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ORIGINAL ARTICLES

VARIATIONS AND MODIFICATIONS OF THE FACIAL FEATURES: AN INTRODUCTORY STUDY*

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THE study of the factor of variation, by which we mean dissimilarity between organs or qualities that are homologous, has led to the concept that variations are of germinal origin, or congenital. Modifications, on the other hand, are wrought in an individual's lifetime, are somatogenic, or acquired.

It is a matter of ordinary observation that every human face presents lineaments of character which stamp it with individuality; probably no other part of the body shows so marked a tendency to variation. Under normal conditions, the various features of the face frequently combine in so harmonious a manner that they reveal a striking symmetry. It is "actually a very wonderful and animated piece of architecture, full of beauty and inspiration for one who looks upon it with a seeing eye and considers its age-long evolution with a comprehending and sympathetic mind."

The variations of the facial features have been carefully examined by students of physical anthropology and continue to attract an increasing number of well-trained investigators. Their methods of inquiry have reached a high degree of development and constitute a highly specialized technic. Thus, photographic and x-ray studies, geometric drawings, plastic reproductions, instruments of precision, comprehensive record sheets, statistical and graphical methods of presentation are all employed.

The denture of man is a very complex mechanism and its structural units and adjacent tissues frequently exhibit *variations* and *modifications*. The history of the teeth, as explained by comparative odontology with the aid of fossil remains, is one of the most complete and interesting narratives that science has ever told; very few departments of knowledge can present a section of the past

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quite as completely. But like many other organs of the body, the teeth have not escaped the enervating influences which our changing diet and modes of life have imposed through centuries of time. The anomalies of dentition have, of course engaged the attention of dentists from time immemorial; but the modifications which these produce in the facial features of man have not been analyzed with the painstaking care which their importance merits. It seems to me that this subject offers a large field for original investigation to orthodontists, because they are qualified by training and opportunity for research in this realm.

Blumenbach (1775), Camper (1792), and Prichard (1836) were the pioneers in the study of the relation of the teeth and jaws to the facial lines of man. Since then, numerous methods for measuring human features have been sufficiently standardized to win universal acceptance.

In his work on "The Races of Europe," Ripley adopts the rule: "Long head, oval face; short head and round face. In proportion as the head becomes broader back of the temples, the face appears relatively shorter. Only a few examples of widespread disharmonism, as it is called, between head and face are known. Among these are the Greenland Eskimos, notwithstanding the fact that they are almost the longest headed race known. The aborigines of Tasmania are also *disharmonic* to a like degree, most other peoples of the earth showing an agreement between facial proportions and those of the head which is sufficiently close to suggest a relation of cause and effect. In Europe, disharmonism is very infrequent among the living populations. At times disharmonism arises in mixed types, wherein the one element contributes the head form while the other persists rather in the facial proportions. Such combinations are apt to occur among the Swiss, lying as they do at the ethnic crossroads of the continent."

In comparing a number of skulls even the beginner experiences little difficulty in detecting differences of shape. "The form of the head is for all racial purposes best measured by what is technically known as the *cephalic index.* This is simply the breadth of the head above the ears expressed in percentage of its length from forehead to back. Assuming that this length is 100, the width is expressed as a fraction of it. As the head becomes proportionately broader —that is, fully rounded viewed from the top down—this cephalic index increases. When it rises above 80, the head is called *brachycephalic;* when it falls below 75, the term *dolichocephalic* is applied to it. Indexes between 75 and 80 are characterized as *mesocephalic.*

The list of variations of the bony structures of the head is quite a long one and the following are mentioned because of their special interest to orthodontists. 1. Variations in the degree of projection of the teeth and jaws in relation to the facial form, which may be determined in crania by means of the *gnathic index.* Measured in this manner, the races of man may be classified into the *prognathic, mesognathic* and *orthognathic* types. 2. Variations in the size of the teeth are grouped into *macrodont, mesodont* and *microdont.* 3. Variations of alignment into *parabolic, hyperbolic, elliptic* and *U-shaped* type of dental arches. 4. Variations in the development of the symphysian angle of the chin, which are termed *protruding, straight* and *receding.*

The diet of an aborigine differs widely from that of a highly civilized

caucasian and exercises such a marked influence on the muscles of mastication that modifications in the position of the temporal ridge, the width of the ascending rami and the angles of the mandible are readily recognized.

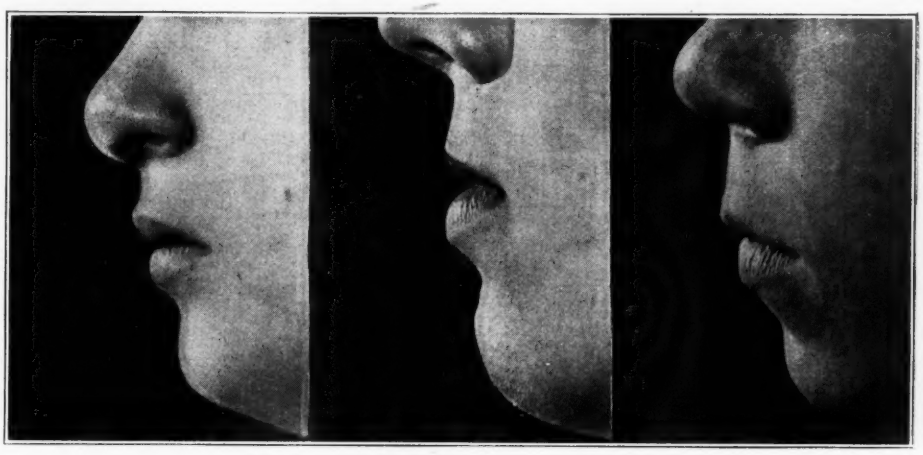

Fig. 1.

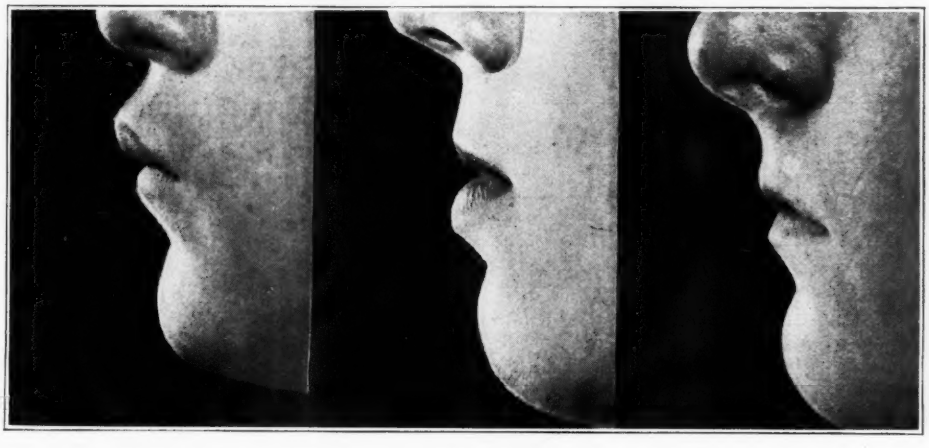

Fig. 2.

Fig. 3.

In a general way, the size and form of the head and face of man are conditioned largely by the bony structures to which the soft parts are attached, but there are many variations of the latter which can not be regarded as dependent upon the former. Let us briefly consider a few of these, especially of the lips and oral fissure. Variations in the length of the upper lip may readily be classified into the *long, medium* and *short* types (Fig. 1). Viewed in profile, we may also recognize the *protruding, straight* and *receding* forms, to which the terms *procheilia, orthocheilia* and *opisthocheilia* are applied (Fig. 2).

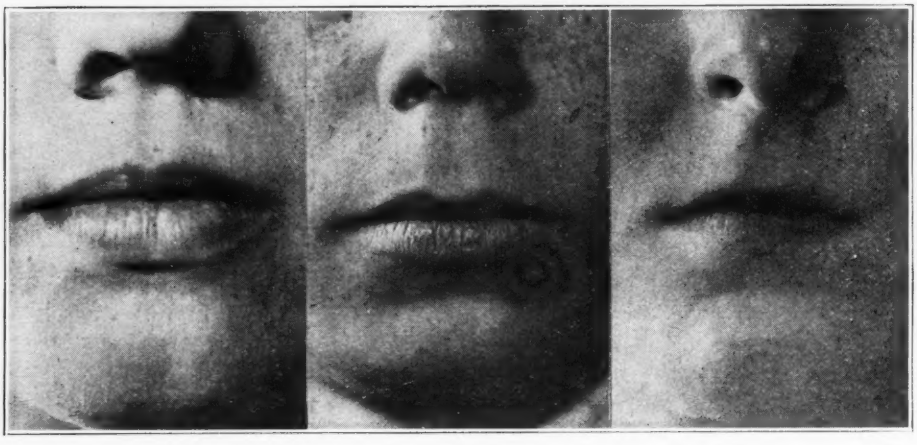

Fig. 4.

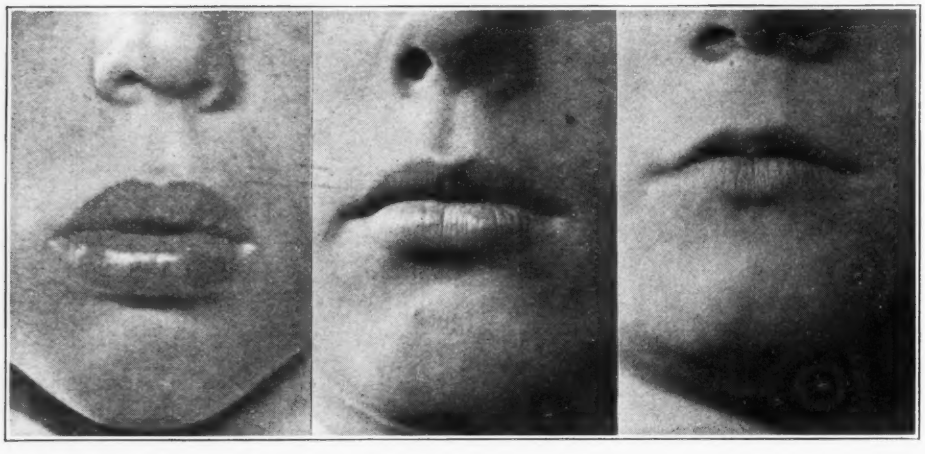

Fig. 5.

The length of the oral fissure differs widely, when measured from cheilion to cheilion, and the variations thus observed may be grouped under the *long, medium* and *short* types, or *macrostomia, mesostomia* and *microstomia* (Fig. 3). The mucuous membrane, or vermilion border, of the upper and lower lips shows a constant tendency to variation into the *narrow. medium* and *wide* types (Figs. 4 and 5). Large lips may be called *macrocheilia* and small lips *microcheilia.*

As orthodontists, we are particularly interested in those modifications of the facial features which are caused by anomalies of dentition. For conven-

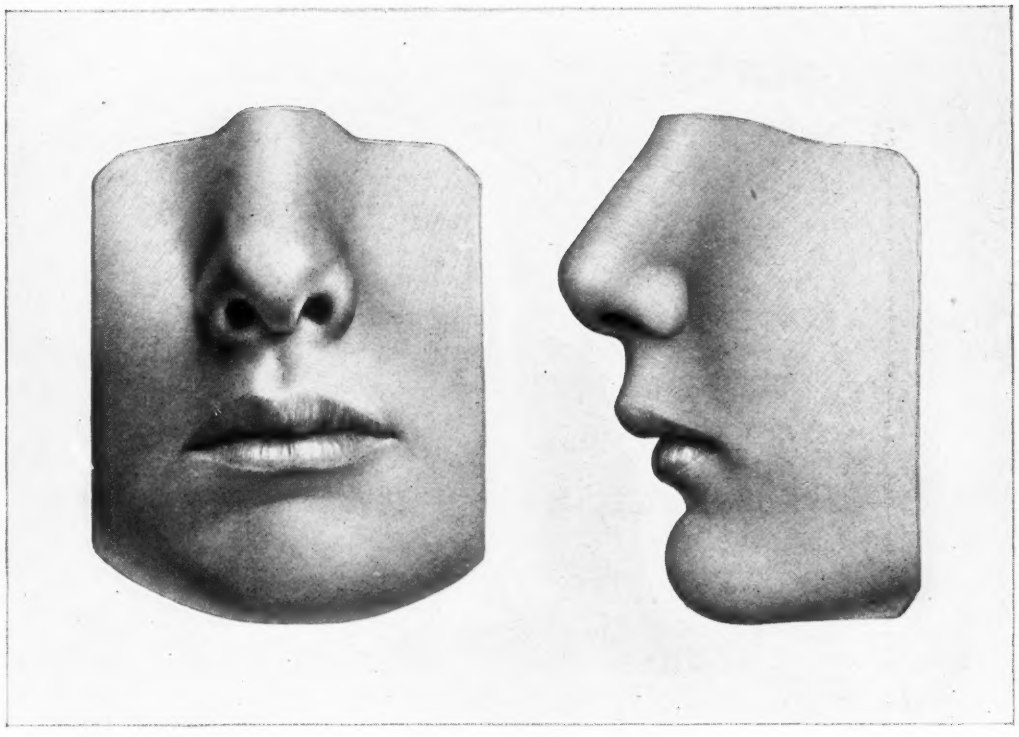

Fig. 6.

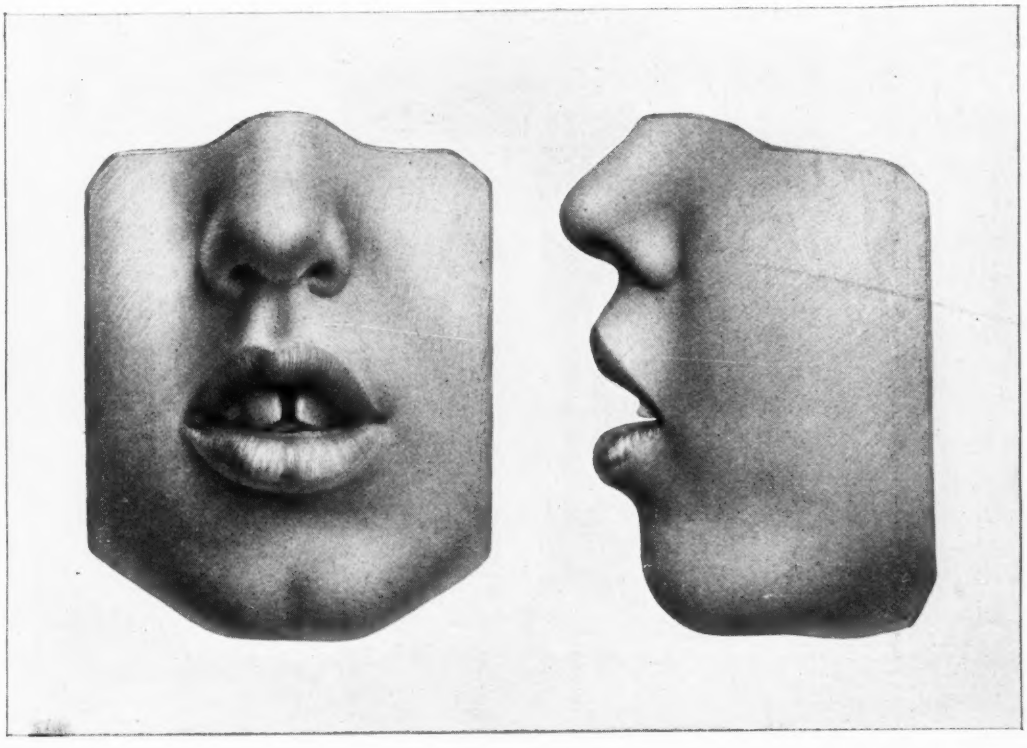

Fig. 7.

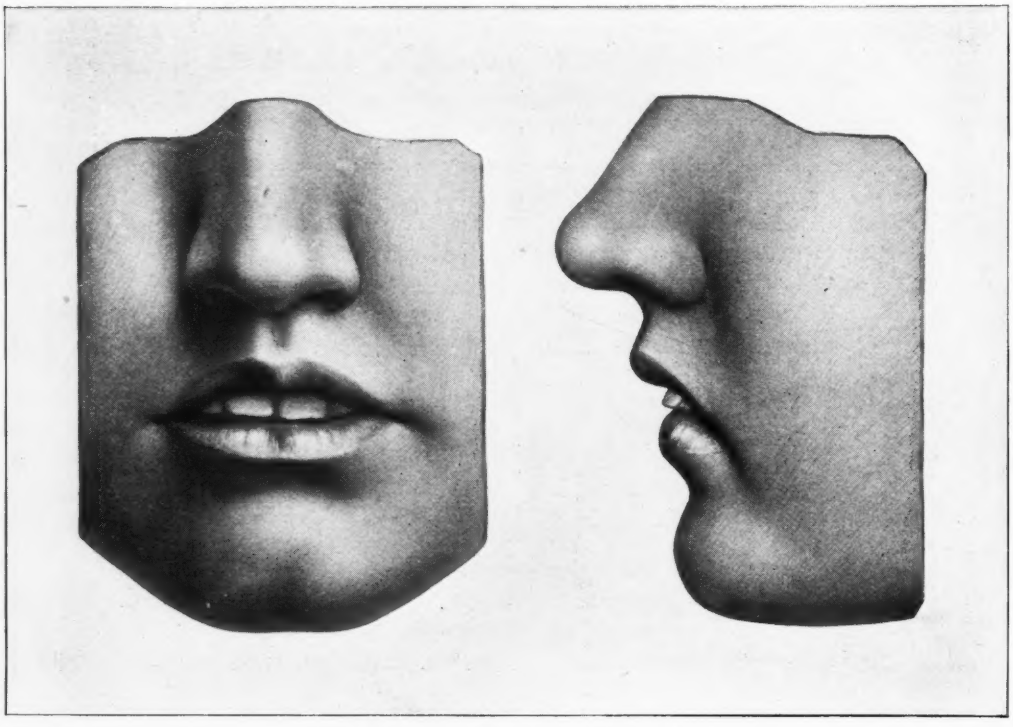

Fig. 8.

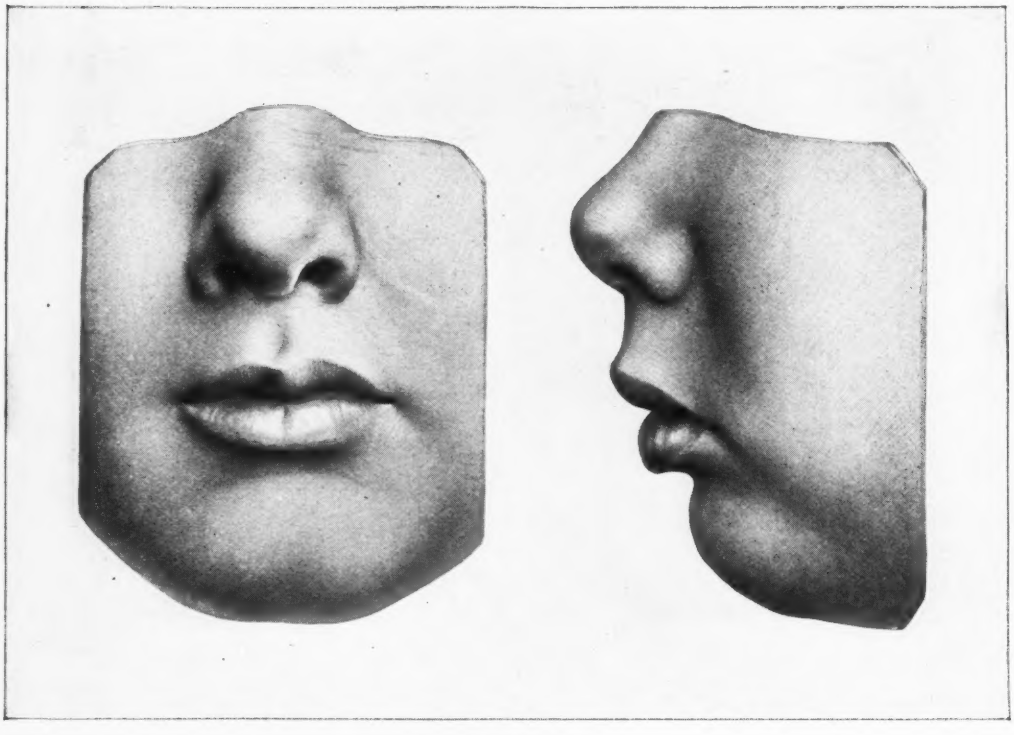

Fig. 9.

ience we may classify these into (a) malrelation of the lips, (b) malfunction of the lips, (c) malformation of the lips and (d) malformation of the jaws and their processes.

Malrelation of the lips may or may not be associated with malfunction and malformation (Fig. 6). In its simplest form it is most frequently found in distoclusion not complicated by mouthbreathing. The dental arches in these cases are more symmetrical in form, though malrelated, and extreme malposition of the anterior teeth is absent.

Malfunction of the lips is usually associated with extreme malposition of the incisors and arrest of development of their surrounding alveoli. It is common even in young patients with mixed dentures, and in neutroclusion and distoclusion complicated by nasal obstruction (Fig. 7).

Malformation of the lips (Fig. 8) is the ultimate result if the above-mentioned modifications are neglected and permitted to continue indefinitely. It is always a serious condition and may be found as a complication in many forms of dentofacial deformity.

Fig. 10.

Malformation of the jaws and *alveolar processes* are fortunately less frequent. They constitute the most difficult lesions with which we have to deal and present a variety of facial modifications. In some of the younger patients with large lips the latter may continue normal functions (Fig. 9); in others, the deformity is so extreme as to involve a number of features so extensively that full correction becomes impossible.

The relation of the *stomion*, or lip line, to the occlusal plane, varies widely among individuals; and in patients presenting dentofacial deformities extreme modifications may occasionally be observed (Fig. 10). All orthodontists of experience have undoubtedly observed this, but thus far it has not been described.

In conclusion, the author offers a very brief consideration of the main facial modifications in *complex neutroclusion.*

Linguoversion of the maxillary incisors is a common complication and results in an easily recognized malrelation of the upper lip (Fig. 11). A thorough

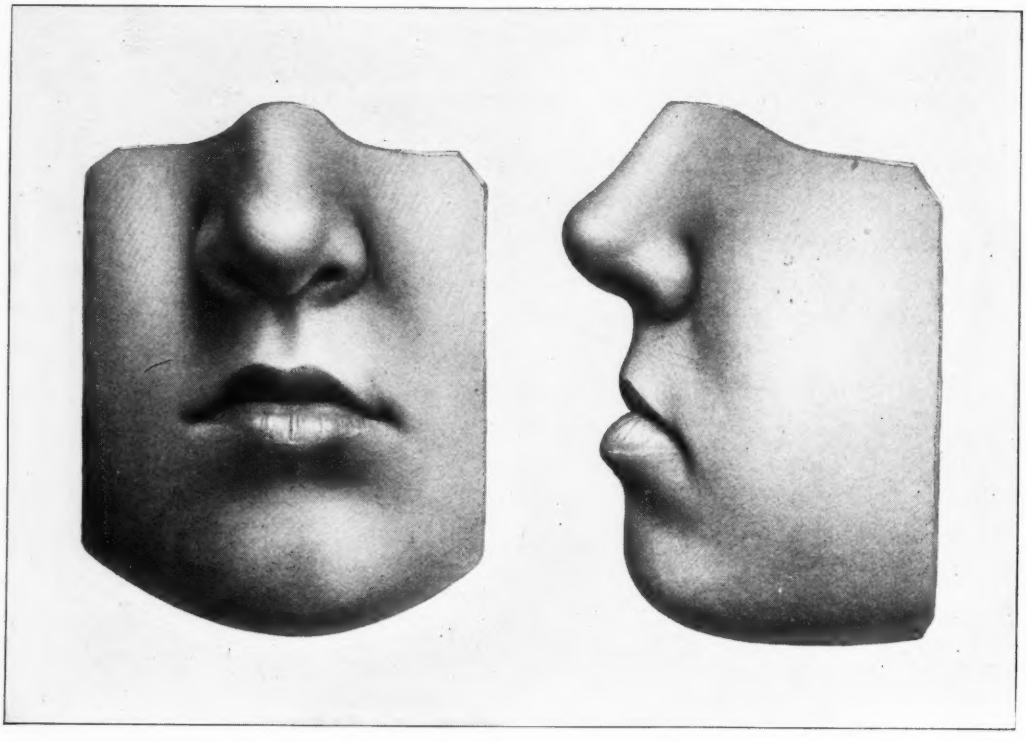

Fig. 11.

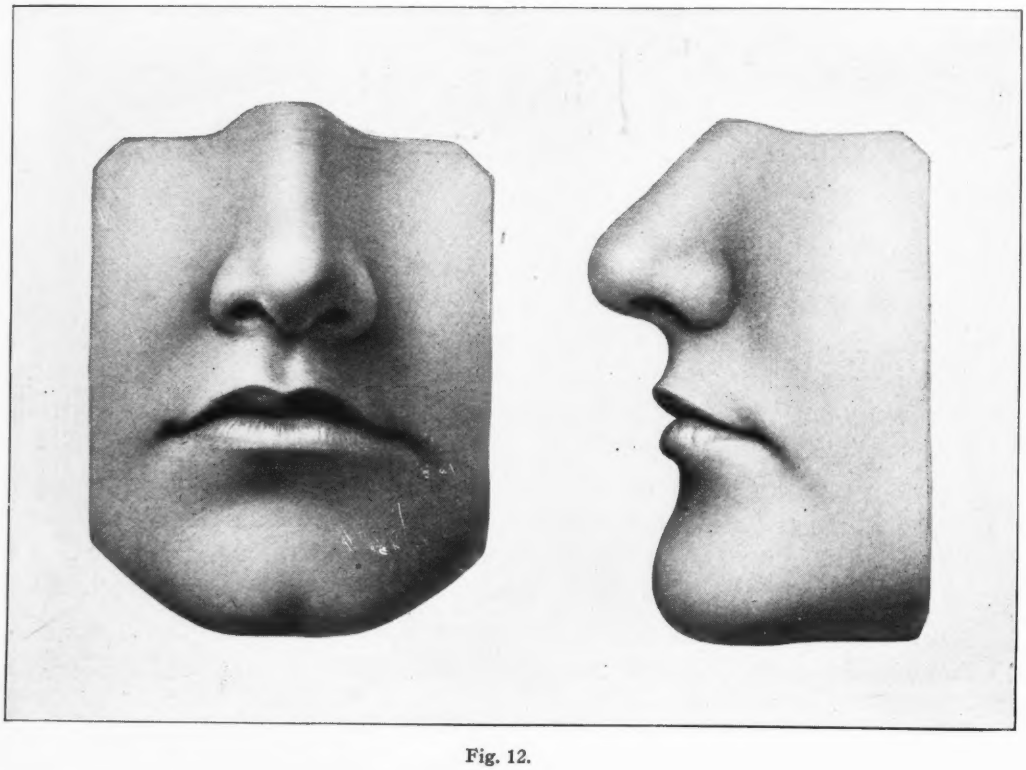

Fig. 12.

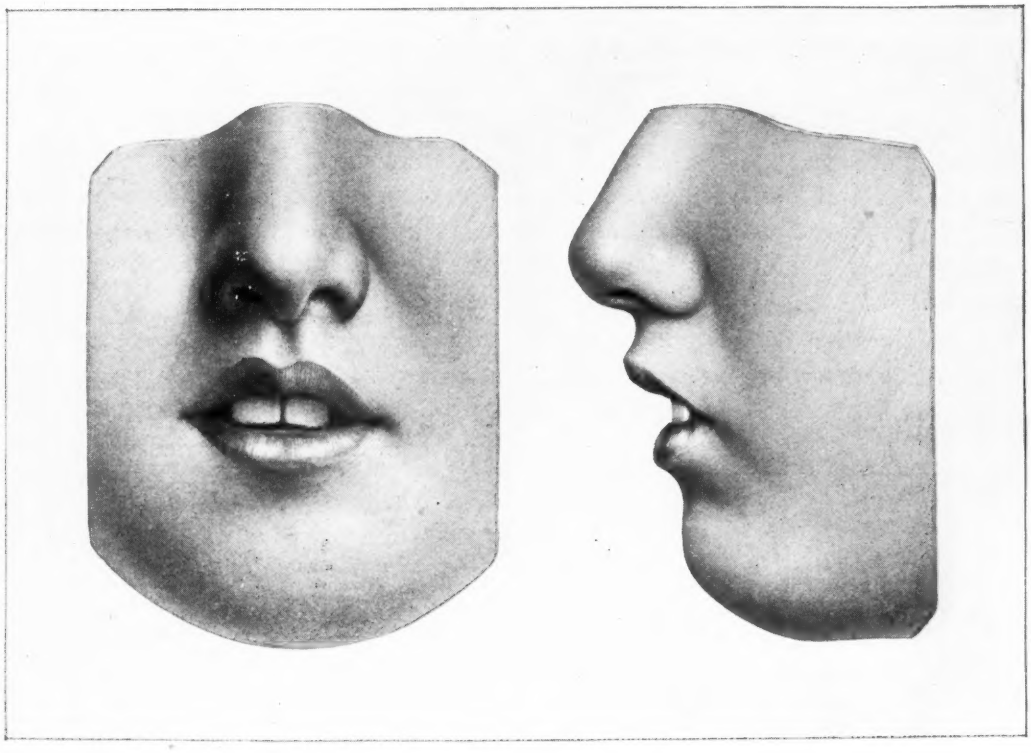

Fig. 13.

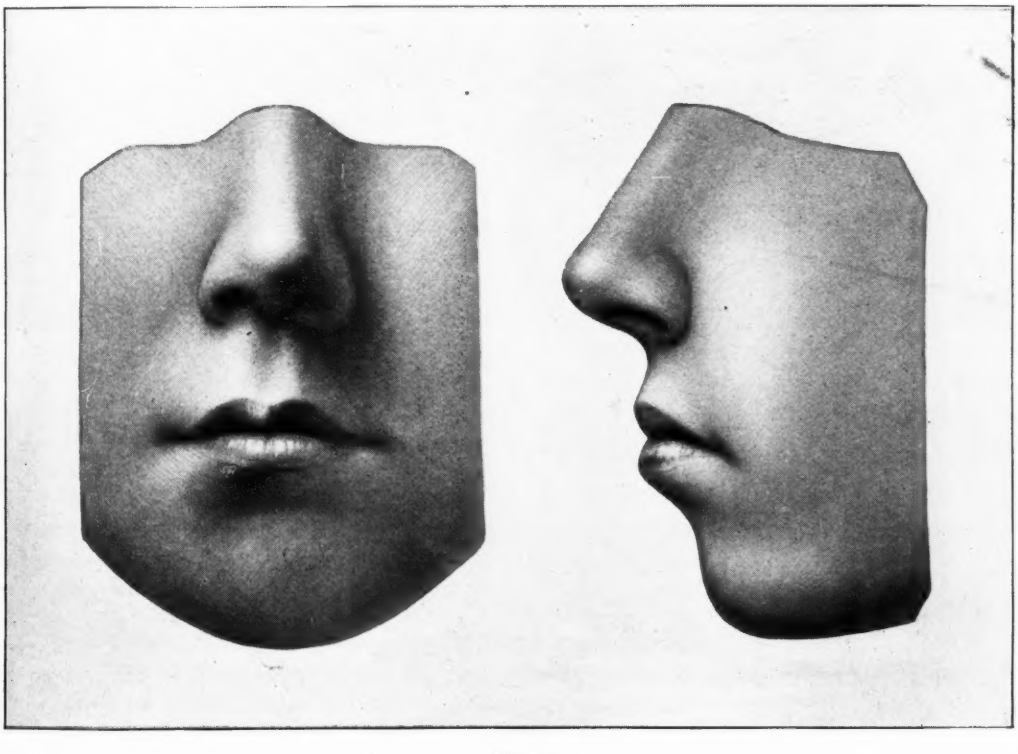

Fig. 14.

study of this modification will reveal many striking deviations. A further complication arises when the mandibular incisors also erupt in linguoversion, with the resultant facial modification differing very considerably from the former (Fig. 12).

Labioversion of the maxillary incisors produces a facial modification of a distinctly different type, and may present malfunction and malformation of the lips. Nasal obstruction and mouth-breathing are common complications (Fig. 13). Arrest of development in the upper lip and the receding type of chin are sometimes combined in the same patient and constitute a very serious deformity.

Labioversion of the mandibular incisors is very rare, but when combined with labioversion of the maxillary incisors a prognathic facial type results (Fig. 14).

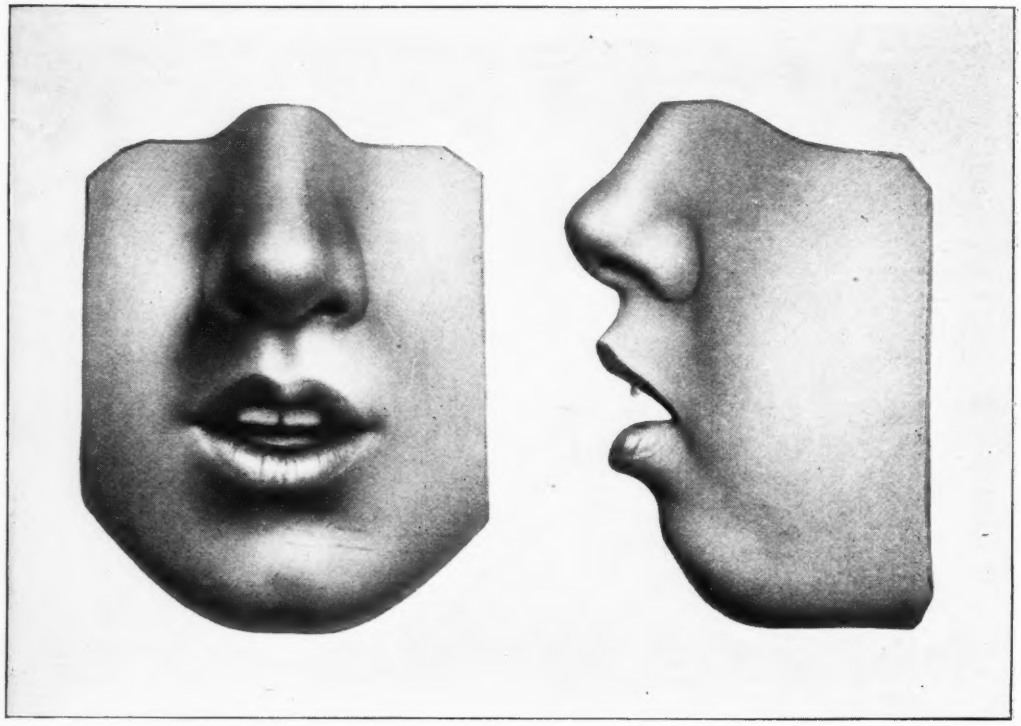

Fig. 15.

Infraversion of the anterior teeth results in a facial modification that differs from any of the foregoing (Fig. 15).

I have given the subject of this paper a great deal of consideration, but this short sketch has been hastily written at the last moment, and amid other pressing duties. It is offered as a mere introductory study in the hope that it will arouse your interest in an important phase of our work.

One or more of the variations and modifications enumerated above may occur in practically every kind of dentofacial deformity. They combine in a great variety of ways and their classification, and the recognition of their sequence and relative significance, is a task for the future.

DISCUSSION

Dr. A. C. Gifford, Oshkosh, Wis.—I believe we can consider ourselves fortunate in having Dr. Lischer bring this subject before us, as I know the majority here have not placed enough importance upon facial art in orthodontics.

One must first be an artist and second have made an extensive study of the variations of facial outline to classify the modifications found in these days of intermarriage of races. This brings about the alteration of head form to such an extent that we find very few true to type features. This intermarriage of races and modern civilization seem to have created a law for each individual, therefore, any fixed type can not now be established as was the case in the time when the Greek face of Apollo Belvedere was the basis or standard. The pleasing physique of our American Indian, with its fine balance, can no longer be found, as it has also succumbed to modern civilization.

Dr. Rogers, of Boston, controls the facial malformations by exercise to develop the muscles and their attachments. He has shown that the muscles of expression and mastication can be developed to the extent of correcting modified features. Dr. Angle has said that the best balance, harmony, and proportions of the mouth in relation to the other features, requires a full complement of teeth, and that each shall occupy its normal position.

There is that stage in the life of a person which shows many modifications and variations, that is, from the time the first temporary teeth are lost until the permanent canines have fully erupted. The features depend almost wholly upon the normal eruption of the teeth, if the face is to develop into the greatest harmony.

The President.—This is a very important paper and the author has brought out a great many points that we should be very much interested in, and I think the paper should be freely discussed. It is now open for general discussion.

Dr. E. G. Weeks, Saginaw, Mich.—I would like to ask Dr. Lischer one question. What does he do with those cases of short upper lip in adult patients, illustrations of which he has shown, and how does he correct them?

Dr. Milo Hellman, New York City.—It is very difficult to follow attentively the reading of a paper of this sort and discuss it in an intelligent manner, but I would like to say a few words touching upon one or two points.

In the first place, I would say that Dr. Lischer ought to be a little easier in expounding these theories because many of them have been contradicted in recent investigations. It is true, they have been accepted by many anthropologists, but recently biologists and ethnologists have not shown any disposition to accept them *in toto*. We ought, therefore, to hesitate before making statements of a definite and positive character.

The point Dr. Lischer mentioned with reference to the ascending ramus,—that it is a structure due to habit or to function—

Dr. Lischer.—To diet.

Dr. Hellman.—remains to be proved. The various races prove definite racial characteristics with reference to the ascending ramus. We have an extremely short and broad ramus in the Eskimo, while we have a long, narrow, comparatively delicate and graceful ramus in the American Indian. The anthropoids show a very broad ramus resembling that of the Eskimo, and our primitive predecessors show similar characteristics to those of the Eskimo and the anthropoids; so that it may be an evolutionary characteristic and not a functional acquisition. I am rather more inclined to attribute it to evolutionary processes.

The relationship between the width of the face and the width of the skull may be found to be dealt with in an interesting manner by Mr. L. R. Sullivan of the American Museum of Natural History of New York in an article on the subject of "Physical Anthropology and Orthodontia" to which he has devoted a good deal of study. It was published in the *Dental Cosmos,* April, 1918, and is of great interest to those acquainted with the subject of anthropology. He bases his deductions on very noteworthy evidence.

As to the face itself, I wish to recommend a very good paper written by Prof. Wm. K. Gregory of the Columbia University, N. Y., on the "Evolution of the Human Face." In that paper he goes through the entire evolutionary process, bringing forward some very interesting evidence bearing on this topic. He presents not only the evolution of the bony struc-

tures, but also the correlative development of the nervous and muscular systems of the head and face, laying some stress on the evolution of the special senses.

I would strongly advise those who are interested in this subject to look up the article of Professor Wm. K. Gregory of Columbia University on the "Evolution of the Human Face," *American Museum Journal,* October, 1917. An abstract of that paper was printed in a recent issue of the *Dental Cosmos.*

Dr. Martin Dewey, Chicago, Ill.—I was very glad to hear Dr. Lischer make a distinction between variation and modification. Environment has much to do with modifications. As regards certain variations in facial development and certain modifications, one must make a careful analysis to see which is which, to determine what has been congenital and what has been the result of environment. Under the head of modifications, you have to consider such conditions as may arise as the result of abnormal development from various sources, and then the other modifications which will be influenced by use. For instance, as regards the short upper lip it may be the result of disuse. One will find it almost always associated with mouth-breathing. We find the thickened lower lip which may be the result of irritation produced by the lip resting against the upper teeth.

In the different varieties and shapes of the mandible, in the development of the chin, we find the chin is claimed by some comparative anatomists to be the result of the development of the organs of speech, because man has a better development of the chin than anthropoids. In certain cases the development of the chin is associated with malocclusions; it may be that the under development is the result of the abnormal use of certain muscles rather than a variation. We find the extreme difference in the development of the mandible in distoclusion as compared with mesioclusion. In the mouth-breather you have a receding chin, while in the normal individual you have a well-developed mandible and a more or less prominent chin. As a result of that, we must not lose sight of the fact that function plays a very important part in the development of the lips, and in the size and shape of the lips, which may be changed by various muscular efforts as shown in a paper presented by Dr. Rogers before the American Society of Orthodontists last year.

In regard to macrodontic, mesodontic, and microdontic races there is no question that the human family can be classified according to the size of the teeth; but again, we have to be very careful in considering that in connection with our patients because a macrodontic condition will resemble one with tooth development of normal size where the rest of the face is not developed. Because the individual presents seemingly macrodontic teeth, there is no reason why he had large tooth germs when born. We have small jaws in many cases because the conditions which produce underdevelopment of the jaw will not cause a lack of development in the size of the teeth. The conditions which influence the supporting structures will not influence the size of the teeth because the latter was worked out before the individual was born. As soon as the enamel organ is formed the size of the teeth is established but the size of the jaw is not determined, and consequently, if anything interferes with the development of the jaws, we may have a patient with seemingly too large teeth for the face.

Dr. Lischer called attention to the inharmonious conditions which may arise in connection with one type of face and one type of cranium and skull. That hardly looks possible because we find existing types and variations in animals where the variation occurs as a result of inherited conditions, and it has reference to types. For instance, the offspring will take the characteristics from one parent or from the other parent, or there may be a blending of the two. If, for instance, the offspring takes the cranial type of one parent and takes the facial type of the same parent, there will not be a mixing up of these different types of faces and craniums any more than mixing up other parts of anatomic structures. But there is no question that there is as close a relation existing between modifications of the face as influenced by malocclusions; and modifications in the shape of the face as influenced by function. We have different shapes of the lips as inherited conditions which can be exemplified again by considering the lips as you find them in the negro, and the upper lip which you find in the Irish races which is so well portrayed by artists. Often the short lip is not because of the inherited condition, but because of

lack of function, and so we have to be careful to give more study to this phase of the subject before we make a diagnosis depending on what is the result of variation and what is modification, and what is lack of function.

Dr. Max C. Ernst, St. Paul, Minn.—It is always interesting to listen to a paper by Dr. Lischer, and that is one of the reasons I am here today.

As he was reading his paper I was reminded of an incident in St. Paul. I was attending a meeting of the Ramsey County Medical Society and was sitting near the secretary. A paper was read and the secretary said to me, "That must have been a very fine paper, but I didn't understand a thing about it." (Laughter.)

I shall look forward with a great deal of pleasure to the publication of Dr. Lischer's paper, so that we can all read it very carefully and see its true merit. I hope the slides will be published in connection with the paper.

If Dr. Lischer got his paper up hurriedly, I suppose most of us ought to be very glad he didn't put much time on it.

Dr. George F. Burke, Detroit, Mich.—I hope when the essayist closes the discussion he will discourse on the subject of suitable exercise for the undevelopment of the lips.

A great many thoughtful men in this special field think that Dr. Rogers presented a subject that has a great deal of merit in it, and a great many men have obtained considerable out of his papers and illustrations, but it seems to me, he would have rendered a much more valuable service in what he has done if he could have presented his technic with the method. His technic could have been presented to great advantage, and it would have been of tremendous educational value to the profession—at least to those who feel that there is merit in this whole proposition of muscle exercises. It is pitiful in the extreme, after having moved a tooth into normal occlusion, particularly in severe cases of distoclusion, to find the upper lip is still short and undeveloped.

I would like to ask Dr. Lischer whether in his opinion a systematic form of exercises will to a considerable degree increase the functional activity of these parts.

Dr. Lischer (closing).—Dr. Weeks and Dr. Burke spoke about the short upper lip and what I did in such cases. I do not want to convey the idea of presenting some new remedy. I merely wanted to call your attention to some observations I have made and to some of the difficulties that have confronted me in my experience. Up to a very recent time I did not think anything could be done for deformed lips except by surgical operation, as outlined in the work by Kolle, of New York. Of course, the suggestions of Dr. Rogers, of Boston, are very encouraging, and I hope will lead to something very definite. I understand he is to present a paper before the American Society of Orthodontists next week; so that we shall probably get further instruction along this line. That offers a ray of hope for dealing with some of these modifications.

Dr. Hellman intimated that some of the theories advocated by anthropologists are of questionable value, and Dr. Dewey spoke about the theory of disharmonism. These have been current in anthropologic literature, which shows that anthropologists have recognized these facts. I do not care what theory you favor as to the cause of a particular variation or modification, but the fact is that it exists, and we have to deal with it.

The point to which I wanted to call attention in my paper, and I had to do it briefly, is that up to the present time most of us have looked upon these facial modifications as *by-products,* which we frequently claim to be able to correct; but we do not study them in a thorough manner, though it is clearly one of our duties. I photograph every patient that applies for treatment, and it is astonishing to note the many surprises such photographs reveal if they are indexed and properly classified. You will notice modifications from time to time that hitherto escaped your attention. It is a good thing to record them in black and white on paper.

If any of you want to take up this work, I shall be glad to help you while you are in our city.

So far as muscular exercises are concerned, I have nothing new to offer.

HISTORY OF ORTHODONTIA

(*Continued from page* 398, *Vol. V*)

By Bernhard Wolf Weinberger, D.D.S., New York City

EDWARD HARTLEY ANGLE, M.D., D.D.S., D.Sc., Founder of *Modern Scientific Orthodontia*. *Provost Smith* upon conferring of honorary degrees at the dedication of the Thomas W. Evans Dental Institute, 1915, expressed the following tribute to our great teacher, in words that can hardly be improved upon, broad in their meaning and true in their statement: "Lover of art and nature, intimate friend of trees and flowers, but pre-eminently founder of the science of orthodontia, to which the best thought of a life has been given in experiments and in test."

To Dr. Angle orthodontia owes that renewed impetus this great thinker has instilled into our science. Probably no one man in dentistry did more to foster

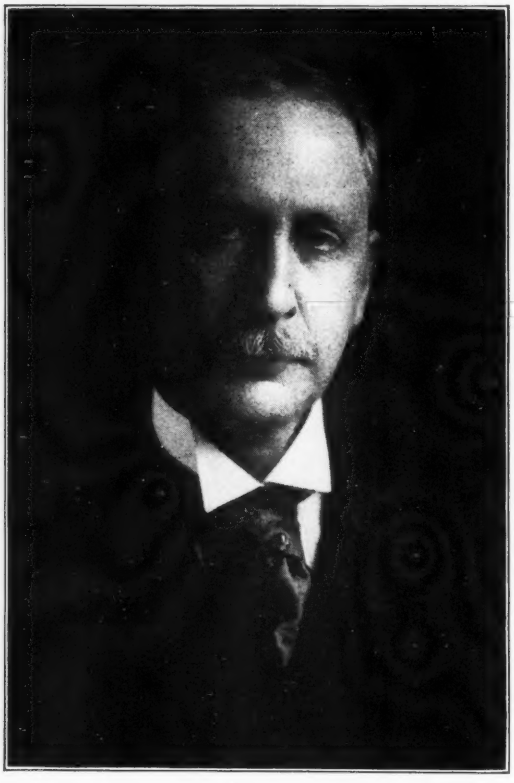

Fig. 1.—Edward Hartley Angle, M.D., D.D.S., D.Sc.

this branch of dental science causing its separation from the general practice, bringing about the specialization and advancing it to a recognized science.

The first to incorporate in his teachings and writings, the views of Davenport and others, publicly emphasizing that extracting of the teeth in order to correct malocclusion was unnecessary and even criminal; the importance of restoring normal occlusion in order that the best results might be obtained and the teeth permanently retained.

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Dr. Angle read his first paper in December, 1886, *Irregularities of the Teeth,* before the Minneapolis Dental Society, repeating this before the Minnesota State Dental Society in May, 1887, and then describing for the first time (in a paper read before the Ninth International Medical Congress, 1887) what is now recognized as the "Angle System." From this simple beginning there has developed that which we now recognize as the leading method of treating irregularities of the teeth. Seven editions of his *Malocclusion of the Teeth* have gone through the press, the last published in 1907, the first in 1887. The second *A System of Appliances for Correcting Irregularities of the Teeth,* 1890. The third, *The Angle System of Regulating and Retention of the Teeth* appeared in 1892 and the fourth edition was issued in 1895 with a second part *Treatment of Fractures of the Maxillæ,* fifth edition in 1899, while the sixth *Malocclusion of the Teeth and Fracture of the Mandible* in 1900. Each edition was more comprehensive than the preceding one and contained all of the advances made by the author in the intervening years. The first five editions were pamphlets, the sixth, however, was more of an elaborate work, in this he clearly sets forth at length his method of operating, the devices he designed and their method of construction, with the added advantage of numerous photographic reproductions of models showing various cases before and after treatment, thus greatly enhancing the value of the work. The seventh edition brought out in 1907, a work of 628 pages, was the last published in English. This edition has been reprinted several times. Besides the English editions there have appeared at least three German translations. The last being a revised edition of the seventh, with the addition of the working retainer and the pin and tube appliance.

In the *American Textbook of Dentistry,* third and fourth editions, Dr. Angle wrote the chapter on *Orthodontia,* the last issued containing his more recent appliance.

Dr. Angle's works have been translated into the French, German, Dutch, Scandinavian and Spanish languages.

The greatest influence in fostering orthodontia and advancing its science was undoubtedly the establishing of the *Angle School of Orthodontia* in 1900, the first postgraduate school for the teaching of this branch of dentistry and medicine and the training of selected men to advance scientific orthodontia. From a small group of men, four in number, *Henry E. Lindas, Thomas B. Mercer, Herbert A. Pullen* and *Milton T. Watson,* the graduates now number more than one hundred and fifty men who later located in every large city in this country as well as in Europe and South America. Dr. Angle was actively at the head of ten sessions of his school.

ANGLE SCHOOL OF ORTHODONTIA

Dr. Angle was the first man to realize that orthodontia and general dentistry were radically different and constituted in reality separate specialties of medicine—dentistry being the study of the diseases of the mouth, orthodontia the study of the relationship of the teeth to the development of the face. To him it was not a part of dentistry, but a sister profession.

Dr. Angle has told in his own words the condition which led up to the establishment of the Angle School and I will include that, as it was given by him-

self. But one who has looked at orthodontia only from the view of dentistry, can not, I believe, understand this development.

"In 1880 I had become very much interested in orthodontia, and I came to believe that some time, perhaps after a long time, orthodontia would be practiced as a specialty, for it seemed to me that its importance entitled it to a closer study and application in practice and that only would enable any one to become sufficiently familiar with its principles and master its technic, to overcome its difficulties and be successful in its practice. This conviction has constantly grown upon me in the years that have followed.

"In 1896 I advocated its teaching and practice as a specialty in a paper read before the Western Pennsylvania Dental Association, which was published in the *Dental Review*. My experience in teaching orthodontia in four different dental colleges, covering a period of thirteen years, convinced me that it was impossible ever to successfully teach it to dental students. This is abundantly proved, I think by the fact that although orthodontia has been a part of the curriculum of all the dental colleges from *Harris'* time down, not one dental student in all that time has gained sufficient knowledge of the subject in the dental college to enable him to practice it with sufficient success to make it his sole means of gaining livelihood, in spite of the immense number of these deformities in every community.

"I then tried hard to impress the management of the dental departments of the Northwestern University and the University of Pennsylvania with the desirability of their forming special departments devoted exclusively to the study and practice of orthodontia. I proposed that orthodontia in these institutions should be made optional; those having an aptitude and liking for the work, giving after the second year, their entire time to its study and practice. The answer was, always, 'This is too Utopian,' or 'It is too early.'

"Having become entirely discouraged with my experiences in dental colleges, I became filled with the belief that if orthodontia was to make any material progress, a separate school, entirely independent of dental schools, must be formed, which would amply provide opportunity for those with aptitude and liking for the subject to study in a broad, thorough and comprehensive manner, and where it would be relieved from all the blighting, handicapping influences which are necessarily thrown around it in dental colleges. Hence was founded the Angle School of Orthodontia."

"In the summer of 1899, at the meeting of the National Dental Association at Niagara Falls, a few young men became very much interested in Dr. Angle and his idea of orthodontia. As a result of the interest awakened, four young men, *Drs. Thomas B. Mercer, Henry E. Lindas, Milton T. Watson,* and *Herbert A. Pullen,* went to St. Louis and spent about three weeks with Dr. Angle in his office." This was the very humble beginning of the Angle School of Orthodontia.

In 1902 Dr. Angle strongly advocated the separation of orthodontia from the general dental profession and making it a distinct specialty, thus fulfilling *Dr. Farrar's* prophecy. For some years previous he devoted his practice exclusively to orthodontia and by the training the men received in his school this branch has now become a distinct specialty of its own.

One of the important factors in advancing Dr. Angle's "System" undoubt-

edly is the classification devised by him and now accepted as the recognized standard in treating malocclusion of the teeth. This classification, with his determined stand against extraction of teeth, will be a lasting memorial to him. This is based upon the different varieties of malocclusion, taking the "constancy of the upper first molar" as a guide, the various types of cases being placed in four groups, and for each group there is prescribed a definite line of treating. This classification has brought a chaotic condition into an orderly and scientific arrangement, best testified by its generally universal acceptance and adoption throughout the whole dental profession. A brief summary of *Dr. Angle's* development of his system is as follows:

The introduction of metal tubes soldered to the band, 1886, providing a "simple, compact, and ready means of attachment between band and working appliance."

Irregularities of the Teeth, (Ninth International Medical Congress) 1887, probably First Angle Edition.

Introduction of *Nickel Silver* (German) in 1887.

Introduction of *Traction Screw* in 1887.

Introduction of *Stationary Anchorage* in 1887.

Introduction of first set of *Angle's Appliances* in 1889.

Introduction of *Silver Solder* in 1890.

A System of Appliances for Correcting Irregularities of the Teeth, Second Edition, 1890.

Introduction of *Occipital Anchorage* in 1891.

Introduction of *Occlusal Anchorage* in 1891.

The Angle System of Regulation and Retention of the Teeth, Third Edition, 1892.

Introduction of *Adjustable Clamp Band,* in 1892.

Introduction of *Angle Impression Trays,* in 1894.

Introduction of *Soft Brass Ligature Wires,* in 1895.

Introduction of *Wire Pinches, Under a New Method of Applying Force in Regulating Teeth,* in 1895.

Fourth Edition of the Angle System of Regulation and Retention of the Teeth, with an addition of *Treatment of Fractures of the Maxillæ,* in 1895.

Introduction of the *Band Forming Pliers,* in 1898.

Fifth Edition of the Angle System of Regulation and Retention of the Teeth, and Treatment of Fractures of the Maxillæ, in 1899.

Introduction of *Resection of Frenum Labii,* in 1899.

Introduction of *Head Gear,* in 1899.

Introduction of *Chin Retractor,* in 1899.

Introduction of *Classification of Malocclusion,* in 1899.

Introduction of *Friction Sleeve Nut,* in 1899.

Malocclusion of the Teeth, Sixth Edition, 1900.

Introduction of *Establishing of the Angle School of Orthodontia,* in 1900.

Some Basic Principles in Orthodontia, in 1902.

Metal Ligatures in Orthodontia, in 1902.

Introduction of *Specialization of Orthodontia,* in 1902.

Introduction of *Normal Occlusion.* The full complement of teeth, and that each tooth shall be made to occupy its normal position, in 1903.

Introduction of *Upper First Molar as a Basis of Diagnosis,* in 1905.

Malocclusion of the Teeth, Seventh Edition, 1907.

Introduction of *Working Retainer,* 1910.

Introduction of *Pin and Tube Appliance,* 1911.

Introduction of *Ribbon Arch,* in 1913.

Notes on Orthodontia with a *New System of Regulation and Retention.* This paper by Dr. Angle was read before the Ninth International Medical Congress in 1887, in which he says:

"In this brief paper I shall confine myself to the consideration of movements of the teeth during treatment, and, later on, shall offer for your consideration some appliances for accomplishing these movements and the retention of the teeth when in proper position. In studying the conditions by which we may best accomplish the movements of the teeth, we may simplify matters if we remember the movements are but five, viz., forward and backward in the line of the arch, inward and outward in the line of the arch and partial rotation. These and their slight modifications (with the exception of elongation and depression, which are so rarely necessary that I will not here speak of them) are all we are called upon to perform. The principles governing all of these movements are the same, so that by understanding the principles governing one we may comprehend them all. Only one of these movements by means of a mechanical appliance should be undertaken at the same time, otherwise the liability to inflammation is greatly increased. After having moved a tooth the desired distance in one direction, it should be firmly stayed from retrogression, when other movements, if desired, may be accomplished. In accomplishing a movement of a tooth by force, it matters little whether the pressure be continuous or intermittent, since the results are the same. The movements of a tooth should be completely under the control of the operator, and should be fast or slow, as his judgment may dictate, system and accuracy being observed at every step. And perhaps no one of the mechanical powers so nearly fills the requirements in aiding the operator in this respect as the screw. It is powerful and compact and the many different ways in which an ingenious operator may make use of it renders its application almost universal, and it may nearly always be used inside of the arch, thus avoiding the appearance of unsightly appliances. Next in value I should place the spring composed of piano wire.

"In applying force to a tooth, it should be sufficient to accomplish the movements as rapidly as is consistent with the laws of physiology.

"When pressure is once applied, it should continue without relinquishment, for there should be no retrogression of the tooth. Indeed, I attach so much importance to this fact that I believe that it may be laid down as a law in orthodontia, for I believe the frequent removal of pressure is contrary to the laws of physiology, and when occurring, as by slipping, breaking appliances, frequent adjustment of ill-designed appliances, or for purposes of cleansing or changing of appliances, is the cause of nearly all the soreness and pain; and, I may add, a

very common cause of failure in regulating. And to this cause, directly, I believe, may be traced strangulation and death of the pulp, which is so often attributed to the too rapid movement of a tooth.

"An appliance for accomplishing the movement of a tooth should be so perfect in design, construction, application and operation that there should be no occasion for its removal until the object for which it was designed is accomplished.

"In the movement of a tooth, it is necessary that the resistance, at the point from which pressure is exerted, should be sufficient to completely overcome the resistance of the tooth being moved, but the regulating appliance should never be allowed to rest in contact with the gum, as no substantial resistance can be gained by so doing, and more or less inflammation will be the result.

"The practice of covering the crowns of the molars or bicuspids with metallic caps or vulcanite, thereby preventing the proper closure of the jaws, is unnecessary, and should be deprecated."

RETAINING APPLIANCES

"On this subject little has been given us, and to this question far too little importance is attached. After the malposed tooth has been moved into the desired position and proper occlusion secured, it should be firmly supported and retained in such position until it has become firm in its socket.

"A retaining appliance should hold the tooth so firmly that there will be no movement to disturb or in any way interfere with the new bone formation. Absolute rest is essential to the most speedy and satisfactory results. The importance of a firm support and rest while the tooth is becoming firm, is well illustrated, says *Guilford,* in the necessity of placing a fractured limb in immovable splints.

"I greatly doubt if alveolar tissue, formed under unfavorable circumstances (such, for instance, as would obtain in malocclusion, or in the use of appliances necessitating frequent springing in and out of place for the purpose of cleansing) would, on close examination, be shown to be normal.

"A retaining appliance should remain stationary until the object for which it was designed is accomplished; at the same time it should be clean, and in no way irritating to adjoining tissues, as it must of necessity be worn for a long time.

"The rotating appliance, a piece of piano wire about two and a half inches in length, is bent at one end into the form of an eye. It is shown in Fig. 2. Rotation by the means of this instrument is accomplished by banding the tooth to be rotated in the usual manner. Before cementing the band in position on the tooth, a piece of joint wire (the bore of which is exactly the size of the piano wire just described), one-fourth of an inch in length, is soldered to the band on the buccal portion, at right angles to the axis of the tooth. The band is now cemented in position on the tooth. The straight end of the piano wire is inserted into the little tube, the other end sprung around and made fast by means of wire ligatures to the tooth nearest the eye. Fig. 2 shows an incisor tooth being rotated by this method. After the tooth has been moved into the desired position, it is retained in such position by moving the spring and inserting a

piece of gold-plated wire into the tube from the opposite side, long enough for the end to rest on the labial surface of the tooth adjoining, as shown in Fig. 2. For accomplishing the movement of a tooth from within outward into line of arch, the jackscrew is used in the following manner: The tooth to be moved is banded and piped, in the manner just described in rotating. Into the palatal side of the band is formed a slot, into which is inserted the flat end of the jackscrew. Resistance for the base of the jackscrew is gained by selecting a sufficient number of teeth to completely resist the pressure of the moving tooth. These teeth are banded in the usual manner and piped, close to and on a line with the gum, and a piece of gold-plated wire is threaded through these little pipes, either before or after cementing the bands in position. Against this wire is placed the base of the jackscrew. Fig. 3 shows the screw in position

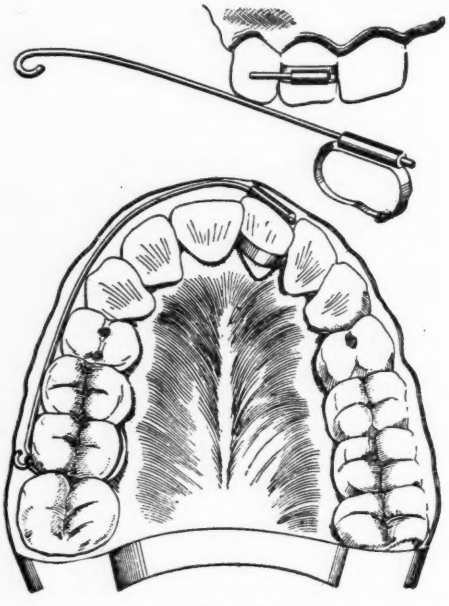

Fig. 2.—Means of rotating anterior teeth (1887).

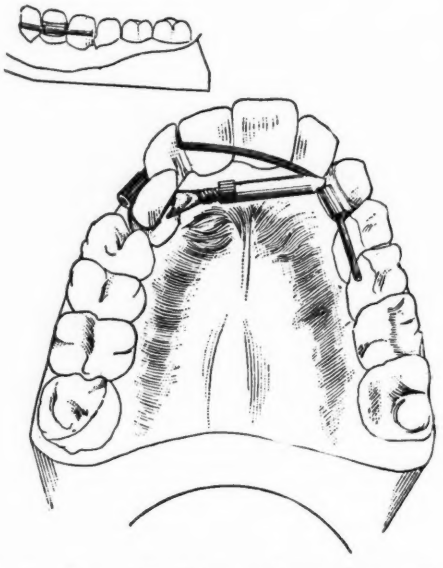

Fig. 3.—Upper, Retaining appliance; Lower, Use of jackscrew.

in moving an inlocked canine. Force is applied by tightening the nut with a small wrench.

"After the tooth is moved into the desired position, it is secured and firmly held in such position by passing a short piece of the gold-plated wire through the little tube previously soldered to the labial or buccal portion of the band, the wire being long enough for the ends to rest upon the labial or buccal surface of the tooth on each side. Thus the tooth is effectually keyed into its new position, as shown in Fig. 3.

"The movement of a tooth from without inward into the line of the arch is accomplished by banding and piping the tooth to be moved, the pipe resting to and on a line with the gum on the palatal side. The angle of the traction-screw is hooked into the pipe. Resistance is gained by banding, piping and wiring together (either gold or piano wire may be used) a sufficient number of teeth in the arch to overcome the resistance of the tooth being moved, the traction screw and nut drawing through and against a short piece of the joint wire

soldered to the wire of resistance on a line with the screw. Fig. 4 shows the screw in position in moving a central incisor. After the tooth is moved into the desired position, it is retained by removing the angle of the screw from the pipe and slipping into its place a short piece of the plated wire, the ends resting against the palatal surface of the tooth on each side, as shown in Fig. 4. The movement of a tooth backward in line of the arch is accomplished by

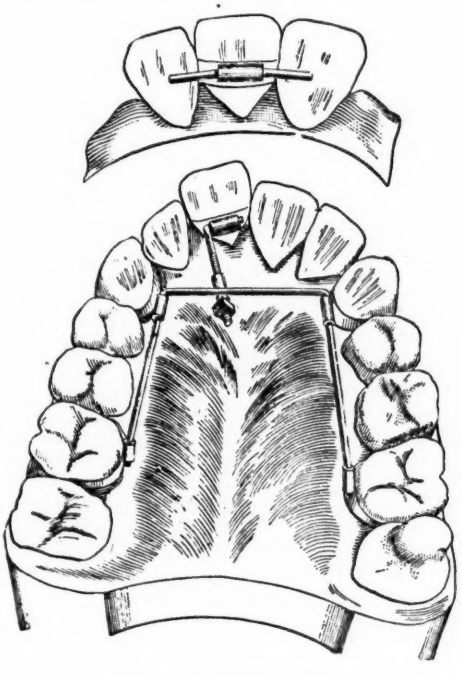

Fig. 4.—Traction screw.

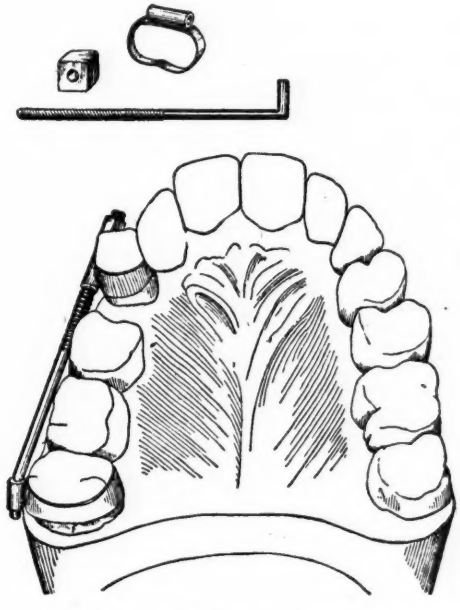

Fig. 5.—Bringing cuspid into line.

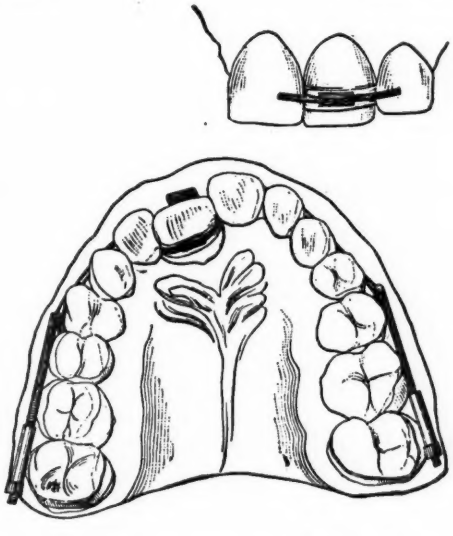

Fig. 6.—Traction screw used to move an "inlocked incisor" into position.

banding and piping the tooth to be moved (for example, a canine) same as for rotation; a suitable tooth for resistance is selected (for example, second molar), banded and piped, the pipe being soldered to the band on a line with the axis of the tooth. Into this pipe is hooked the angle of the traction screw. (A longer

screw than the one first described is used, but of the same gauge.) The screw is passed through the pipe in the tooth to be moved and the nut applied. Fig. 5 shows appliance in position. The nut is tightened as often as necessary, and the screw, as it passes through the nut and becomes irritating to the lips, is snipped off. After the tooth has been moved back the desired distance, it is retained in such a position by the screw already in position, or the screw may be removed and the plated wire inserted in its stead.

"The movement of a tooth forward in line of the arch is accomplished in the same way, only selecting a tooth of resistance from the opposite side. Such are the general ways of using these appliances, but the different ways in which they may be applied are almost limitless, each case requiring some slight modification. Fig. 6 shows the manner in which the traction screw may be used in moving into line an inlocked incisor, at the same time expanding the arch.

"The ligature represented by a dark line in the drawing is composed of fine steel wire annealed. Fig. 7 shows the method in which the arch may be expanded by using two short jackscrews soldered to heavy pieces of brass wire

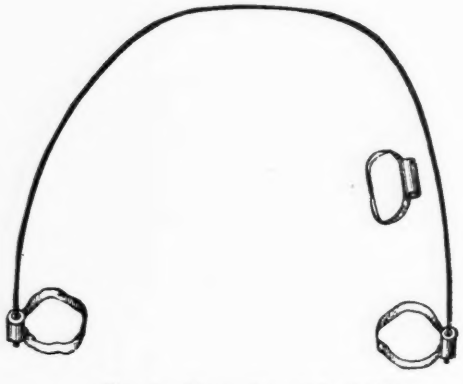

Fig. 7.—Expansion arch (1887).

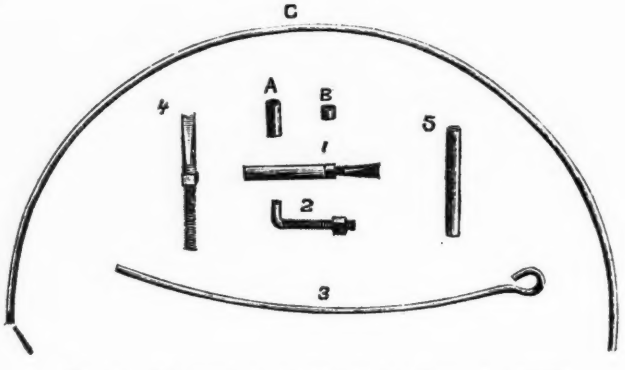

Fig. 8.—Original set of "Angle Appliances" (1888).

bent to conform to the shape of the palatine arch. The screws in this case are about one-quarter of an inch in length; after the nut has been tightened until the screw is nearly passed over it, it is removed and the bent portion of the heavy brass straightened or drawn out, in order to gain more purchase for the screw. Only one of these appliances is removed and straightened at a time, the other one remaining in position in order to prevent retrogression of the teeth being moved.

"In conclusion, let me add, the greatest care and accuracy should be observed in the construction, application and use of these appliances. The little tubes should be of gold and fit snugly the different parts of the appliances passing through them, and if you will derive as much satisfaction in using them as I have, I shall feel abundantly repaid."

Extracts of this paper were also published in the *Ohio Journal of Dental Science* and *The Items of Interest* for 1887.

In the January, 1888, number of the *Ohio Journal of Dental Science* under *The Angle System of Regulation and Retention* we find a continuation of the above article with a few additional illustrations.

"In former numbers of the above Journal I gave the main principles of my system for correcting irregularities. I now propose to report from time to time cases in practice, illustrating more fully the application of the principles of this system." One of these reports is found on page 123 of the 1888 *Ohio Journal of Dental Science.* Another on page 306. The following illustrations are from these reports and describe themselves.

"Fig. 8, original set of Angle Appliances.

"Fig. 9 shows a cuspid being drawn backward.

"Fig. 10, means of expanding the posterior maxillary arch, as described by Angle:

"The opposite ends resting against the bars of steel; expansion is gained by tightening the nut on the screw. A better method of applying pressure against these two bars is to bend a piece of heavy steel wire to conform to the curve of the

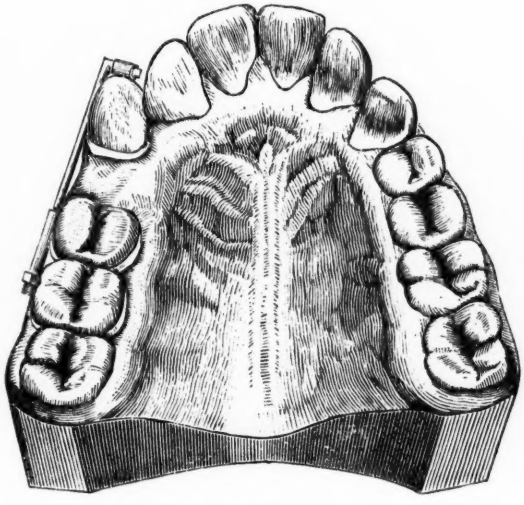

Fig. 9.—Moving cuspid into line (1888).

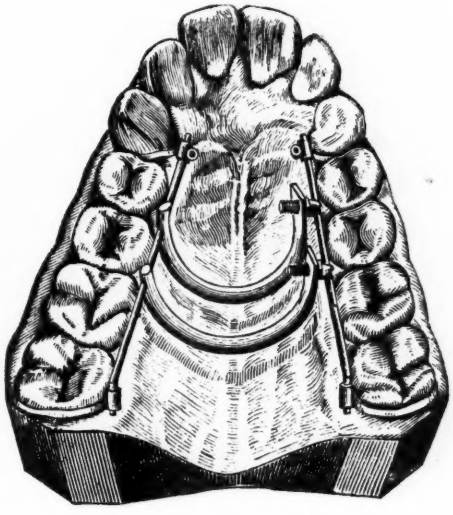

Fig. 11.—Fig. 10 applied.

Fig. 10.—Expanding posterior maxillary arch (1888).

arch across from bar to bar. At the side near one end is filed a notch fitting neatly one of the bars which it is to rest against. The other end is beaten slightly flat and a hole drilled through at a point directly opposite the other bar on that side of the arch. Through this hole is placed a screw for pushing as shown in Fig. 10. The screw should not be over ¼ of an inch in length. This appliance is now ready to place in position as shown in Fig. 10. It is in position in Fig. 11. Pressure is exerted by tightening the nut. After the nut has traveled the length of the screw, the bent wire is removed and straightened a little that the screw may have more action.

"It will be seen in the engraving that the two of these screws and braces are used, one is to remain in position while the other is being straightened, thus preventing the teeth from moving back, as would be the case if but one was used. The braces are moved along the bars forward or backward according as pressure is needed. After the sides of the arch have been pressed apart the de-

Fig. 12.—Retaining arch.

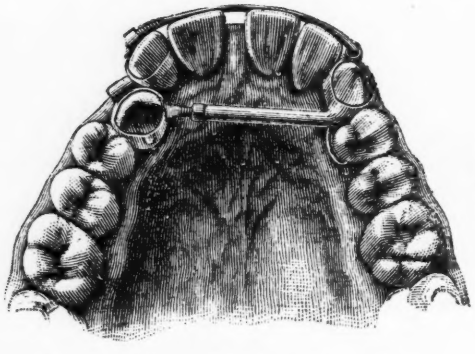

Fig. 13.—Expanding in cuspid region.

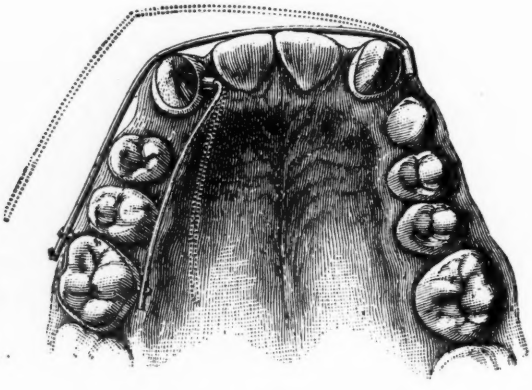

Fig. 14.—Rotating teeth (1888).

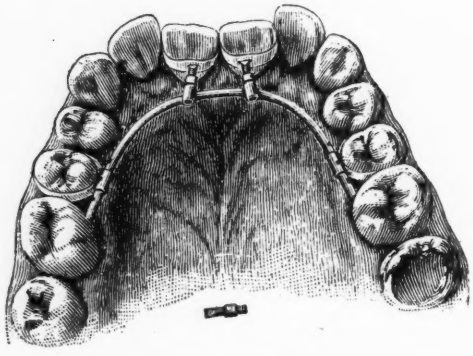

Fig. 15A.—Bringing forward the anterior teeth.

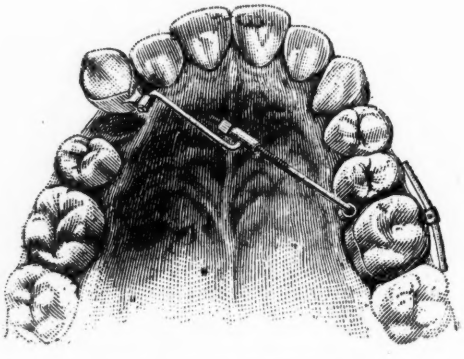

Fig. 15B.—Use of traction screw.

sired distance, they are retained by a straight bar passing across the arch from cuspid to cuspid, the ends being bent sharply at right angles and hooked into pipes already described and attached to bands encircling the cuspids. The incisors are drawn into line by means of the traction screw, this cross bar serving as the wire of resistance for the traction screw to pull to.

"This method of expansion may be applied to the lower arch as well, as little interference is offered to the movement of the tongue."

Fig. 12 shows the retaining arch as used by Angle at that time.

Fig. 13 is an appliance described on page 123 of the above journal.

Fig. 14, means of rotating teeth.

Fig. 15, method of bringing forward the anterior teeth.

The *International Dental Journal,* 1889, page 323, contains another of the early articles of *Dr. Angle's* Regulating Appliance. The case in question was one of Excessive Protrusion.

"The value of the occipital bandage, as a means of anchorage is, I believe,

Fig. 16.—Appliance as used in 1889.

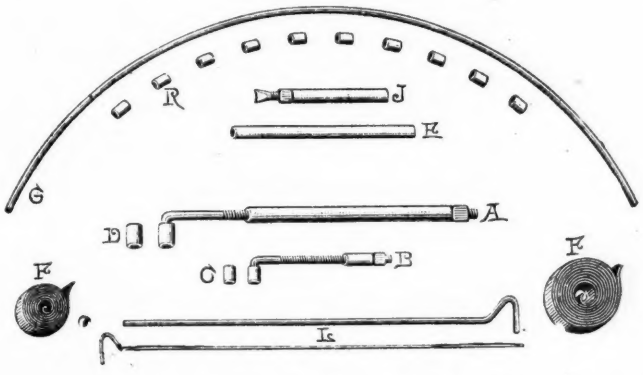

Fig. 17.—Second set of "Angle Appliances."

becoming more and more appreciated, and is especially applicable to this class of cases. I am using the appliance herein described, in my sixteenth case, and I consider it much more satisfactory than any of the few devices which are described in our literature on this subject. This is shown in part in Fig. 16.

"It is made and applied as follows:

"The first molars are carefully and accurately banded. These bands may be made of gold or platinum; but what I regard much better than either, on account of its tensile strength, is German Silver, rolled to No. 36 gauge, shown in *F* in Fig. 17.

"Little pipes about five-eighths of an inch in length are soldered on the side of the arch to the bands. A wire of *hard drawn* platinized gold, about No. 19 gauge, and long enough to encircle the arch is now carefully bent to conform to the shape of the arch, if the arch be correct in form; but if it be contracted or

the teeth irregular, no attention is paid to the form of the existing arch, but an *ideal arch* for the case is made by bending the wire arch to the exact shape to which we wish the teeth in the arch to arrange themselves when the operation is completed.

"The ends of this ideal arch are now slipped into the pipes on the molars. The anterior part of the arch is kept from sliding up and impinging upon the gum, by resting in suitable niches formed in the delicate bands encircling, and cemented to the central incisors.

"It will also be seen by referring to this cut that two small pipes or collars have been slipped on the wire arch, and are shown in the region of the cuspids. (Also shown at *R* in Fig. 17.)

"These collars are prevented from slipping by being previously soldered into place, care being taken to use *soft solder,* that the temper may not be drawn

Fig. 18.—Head cap (1889).

from the wire arch. The collars are for the purpose of preventing the silk ligatures shown in the cut from slipping backward on the wire. These silk ligatures serve to attach delicate rubber ligatures, which have been hooked over the ends of the little pipes on the anchor teeth, and are represented in dark lines in Fig. 16. The use of these rubber ligatures will be explained further on. A traction bar is used in conveying the force from the occipital bandage distributing it to the wire arch.

"A spur about three-eighths of an inch in length will be seen in the center of this bar, it has a deep niche in one end, which when in position, is placed in contact with the wire arch, at a point between the central incisors. Heavy rubber bands are now attached to the occipital bandage, the other ends being hooked over the traction bar. Shown in position in Fig. 18.

"If the reader is familiar with the appliance so far described, it will be seen that the force received from the occipital bandage, is distributed to the wire arch practically through a ball-and-socket joint, as the ends of the traction bar may be

moved in any direction without interfering with the pressure from the bandage.

"As for the bandage proper, I greatly prefer the common silk traveling cap, shown in the engraving, or the knit jersey cap, to the contrivance usually used for this purpose, as these fit the head snugly, thereby distributing the force exerted by the strong ligature over more surface, and are consequently more easily worn. Two ligatures should be attached to the cap, one above the ear, and one below, as shown in Fig. 18. If the bands be of equal width, the force will be exerted in the direction of the meatus of the ear."

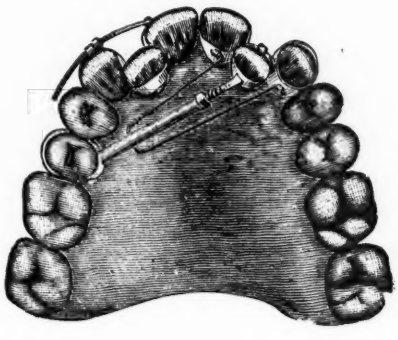

Fig. 19.—Increased anchorage.

Fig. 20.—Modification of Fig. 16, found in the third edition of Doctor Angle's Book.

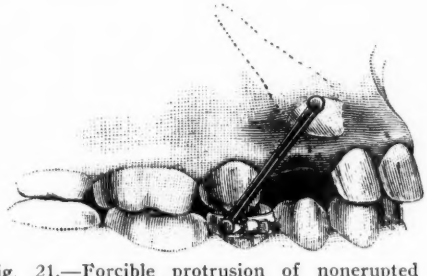

Fig. 21.—Forcible protrusion of nonerupted or partially erupted teeth.

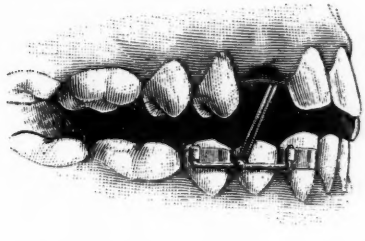

Fig. 22.—Forcible protrusion of nonerupted or partially erupted teeth.

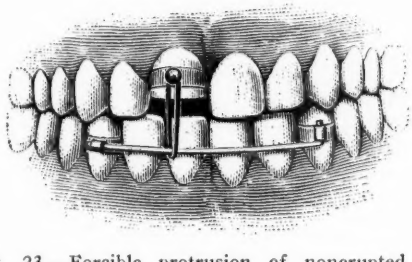

Fig. 23.—Forcible protrusion of nonerupted or partially erupted teeth.

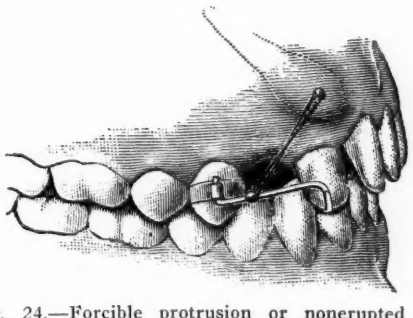

Fig. 24.—Forcible protrusion or nonerupted or partially erupted teeth.

Fig. 19 is from a *Report of Cases in Orthodontia,* 1889, *Ohio Journal of Dental Science.*

Fig. 20 is a modification of Fig. 16 and is described in Angle's third edition.

Dental Cosmos, 1891, Forcible Protrusion of Non- or Partially Erupted Teeth. The following four illustrations describe the method *Angle* then used to bring down these teeth. Figs. 21, 22, 23 and 24.

Dental Digest, page 6, 1895, *A New Method of Applying Force in the Regula-*

tion of Teeth. Here we find a new method of applying force by means of the *Wire Stretching Pliers,* Fig. 25.

Dental Cosmos, March, 1899, page 248, *Classification of Malocclusion.* In this article we find undoubtedly one of Dr. Angle's greatest contributions to orthodontia.

"The term *Irregularities of the Teeth,* as it is usually applied to express teeth that are twisted or unevenly arranged, does not, in the author's opinion, properly express the full meaning of these deformities. It would seem that the term "malocclusion" would be far more expressive; for in studying the subject, we must not lose sight of the importance of the dental apparatus as a whole and the important relations not only of the two arches to each other; but of the individual teeth to one another. The shapes of the cusps, crowns, roots, and the very structure are all designed for the purpose of making occlusion the one grand object, in order that they may best serve the purpose for which they are designed,

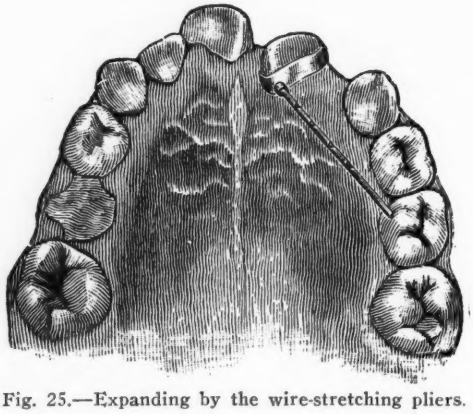

Fig. 25.—Expanding by the wire-stretching pliers.

namely, the cutting and grinding of the food. Examined carefully, it will be seen that there can be no "irregularities" of the teeth if they are in perfect occlusion, but that all must be regular and even, each contributing to the support of the others, and all in perfect harmony. Not only this, but the jaws, the muscles of mastication, the lips, and even the facial lines, probably, will be in best harmony with the peculiar facial type of the individual.

"Therefore, it would seem that the term malocclusion of any tooth or number of teeth would not only better express the true condition, but naturally and constantly suggest the paramount importance of occlusion in the study and treatment of these deformities, instead of making it secondary or even losing sight of it entirely, as has been too much the case in the past. The author has become firmly convinced that occlusion is the very basis of the science, and that in the treatment of cases, unless occlusion is established, the results will be largely of the nature of failures. So in the pages that are to follow we will make occlusion the central thought, and on it base the classification of "irregularities" as well as the nomenclature; and will define orthodontia as being that science which has for its object the correction of malocclusion of the teeth.

"In order to diagnose all cases of malocclusion correctly it is necessary to be familiar with, first, the normal or ideal occlusion of the teeth; second, the normal facial lines. These must be so fixed in the mind as to form the basis from which

to reason, and to intelligently note all deviations from the normal; and it must follow that without clear, fixed, and definite ideas as to the normal, the limits or boundary lines of the abnormal must also be vague and indefinite, and the line of treatment the merest empiricism.

"A knowledge of the occlusion of teeth being the first importance, should embrace a knowledge of not only the normal relations of the occlusal surfaces of both permanent and deciduous teeth, but of their entire forms and structures. The growth and normal development of the jaws and muscles, together with the development of the teeth and the normal periods for taking their positions in the arches, should receive careful attention. Our perceptions of the subject would be broadened also by a comparative study of the occlusion of the teeth of the lower animals."

As this article covers some thirty odd pages it will be impossible to include it in this historical review and fearing that injustice might be done same by reviewing or extracting parts, the author advises that his readers review the article in the above journal or the sixth edition of Angle's book.

There is some slight difference in the wording of the classification as will be seen by comparing the one from the *Dental Cosmos* and the other found in the sixth or seventh edition, and therefore both are included in this historical resume. (*Dental Cosmos,* page 264.)

CLASS 1.

Relative position of the dental arches, mesio-distally, normal, with malocclusions usually confined to the anterior teeth.

CLASS 2

Retrusion of the lower jaw, with distal occlusion of the lower teeth.

Division 1.

(a) Narrow upper arch, with lengthened and prominent upper incisors; lack of nasal and lip function. Mouth-breathers.

(b) Same as *a,* but with only one lateral half of the arch involved, the other being normal. Mouth-breathers.

Division 2.

(a) Slight narrowing of the upper arch; bunching of the upper incisors, with overlapping and lingual inclination; normal lip and nasal function.

(b) Same as *a,* but with only one lateral half of the arch involved, the other being normal; normal lip and mouth function.

CLASS 3

(a) Protrusion of the lower jaw, with mesial occlusion of the lower teeth; lower incisors and cuspids inclined lingually.

(b) Same as *a,* but with only one-half of the lateral arch involved, the other being normal.

OUT OF SEVERAL THOUSAND CASES OF MALOCCLUSION EXAMINED THE PROPORTION PER THOUSAND BELONGING TO EACH CLASS WAS AS FOLLOWS:

Class 1	692
Class 2	
Division 1	90
Subdivision 1	34
Division 2	42
Subdivision 2	100
Class 3	34
Subdivision	8
	1000

(*Seventh Edition*, page 57.)

Class 1. Arches in normal mesio-distal relations.

Class 2. Lower arch distal to normal in its relation to upper arch.

Division 1. Bilaterally distal, protruding upper incisors. Usually mouth-breathers.

Subdivision. Unilaterally distal, protruding upper incisors. Usually mouth-breathers.

Division 2. Bilaterally distal, retruding upper incisors. Normal breathers.

Subdivision. Unilaterally distal, retruding upper incisors. Normal breathers.

Class 3. Lower arch mesial to normal in its relations to upper arch.

Division. Bilaterally mesial.

Subdivision. Unilaterally mesial.

Orthodontia—New Combination of Well-Known Appliance—Forms of Appliances, Dental Cosmos, 836, 1899, p. 836. We here find for the first time the use of the *Friction Sleeve Nut.*

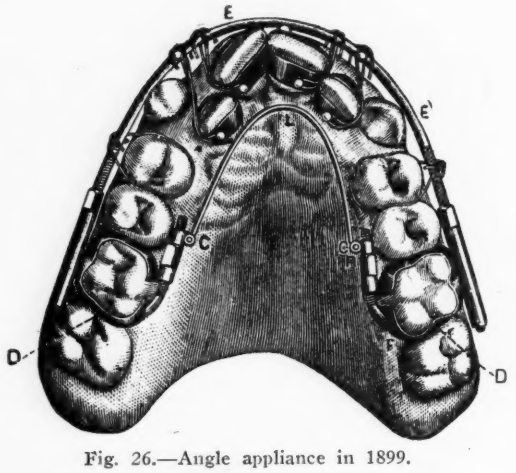

Fig. 26.—Angle appliance in 1899.

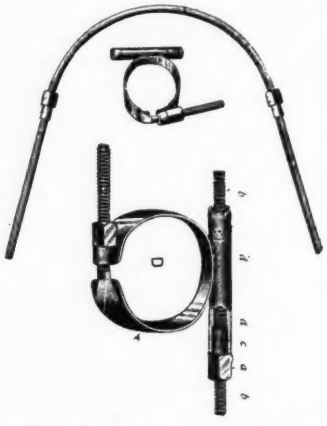

Fig. 27.—"D" bands and expansion arch, with friction sleeve nut.

"The expansion arch possesses qualities which will probably always keep it easily in the lead of all other regulating appliances. By its use we have control over the entire dental arch; over the teeth individually as well as collectively in contradistinction to the vast number of appliances which have been devised to act locally, principally by reciprocal force upon the malposed teeth alone, and by which so acting usually effect displacement of others originally in correct position, so that these in turn require additional devices for their correction, etc.

"Again, with the arch we have the greatest control over anchorage, being able to employ simple, reinforced, reciprocal, and even a certain amount of stationary anchorage, so that it is possible to concentrate upon one tooth the combined resistance of all the remaining teeth.

"Finally, it is an ideal pattern to guide in tooth-movement, and to which the dental arch is molded to conform, besides being a temporary retainer as well.

"In the improved form, as here shown, Fig. 26, it is believed that its size, proportion, strength, and elasticity, as well as stability of anchorage and attachments, are probably very nearly perfect. Fig. 27 is part of Fig. 26.

"Without doubt the greatest improvement which it has received in recent years is the substitution of annealed brass wire ligatures, Nos. 26 and 28, for the long-used fibrous or elastic ligatures, which were uncleanly, admitted of slipping and stretching, and exerted only a moderate amount of pressure. With a proper quality of wire ligature there is no slipping or stretching, and power being direct and positive and the maximum amount of force easily exerted. Most valuable of all, these ligatures may be tightened without renewal by an

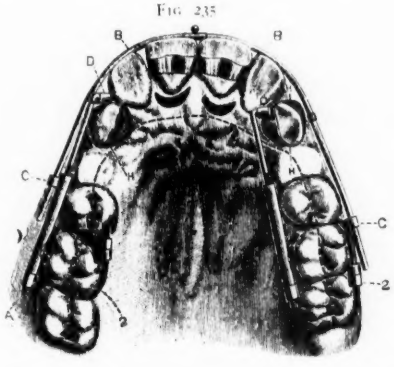

Fig. 28.—Traction screw used in combination with the expansion arch.

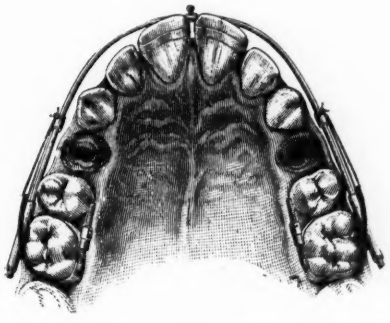

Fig. 29.—Appliance used in 1889, as in Fig. 16.

Fig. 31.—Various "D" and "X" bands.

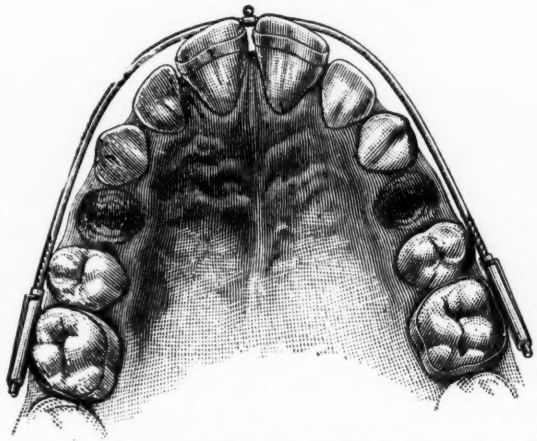

Fig. 30.—Appliance (Fig. 20.) applied to the teeth.

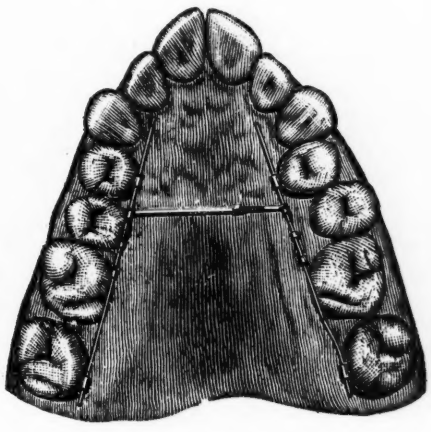

Fig. 32.—Appliances found in the third edition of Doctor Angle's book.

additional twist of their united ends, thus really adding to the ligature that ideal power, the screw. So the range of application and usefulness of the arch has been greatly extended, and, as well, the time of treatment with its use has been reduced fully one-half.

"The latest improvement of the arch is the extension flange or friction sleeve upon the nut, which fits with great accuracy into the sheath upon the clamp band

D and effectually prevents the annoyance of the nut becoming loosened by the friction of tongue or cheek. At the same time longer thread and consequent greater strength is gained without increase of bulk.

"In the intelligent use of the arch the teeth may be moved *en masse;* either arch may be widened by moving outward one or both of its lateral halves, or either may be lengthened or enlarged in any portion in front or on one or both sides thereof. Elevation, depression, or rotation, labial, lingual, or mesial movements of individual teeth may be accomplished with certainty and under the best control.

"But for the purpose of shortening the dental arch on one or both sides after extraction of a tooth, or the front by the moving inward of protruding

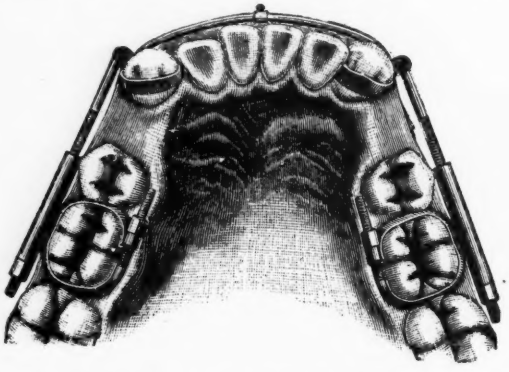

Fig. 33.—Appliances found in the third edition of Doctor Angle's book.

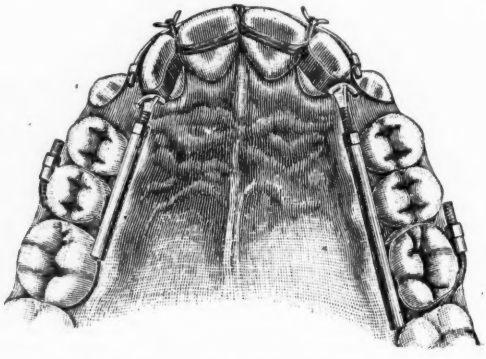

Fig. 34.—Appliances found in the third edition of Doctor Angle's book.

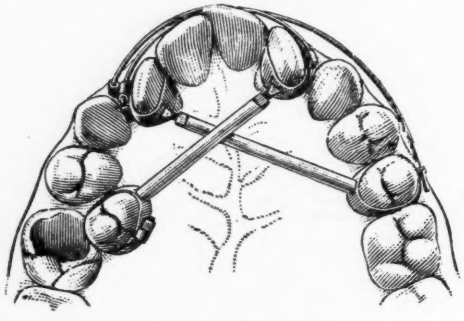

Fig. 35.—Appliances found in the third edition of Doctor Angle's book.

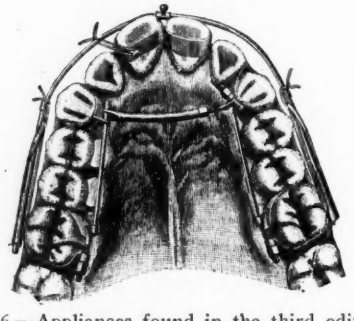

Fig. 36.—Appliances found in the third edition of Doctor Angle's book.

teeth, or for the distal movement of individual teeth, the expansion arch by itself is unsuited and should never be employed; not that it lacks in power, for this is ample, but for the reason that displacement of the anchor teeth will follow, their resistance being insufficient to overcome that of the moving teeth. It is the common experience of all that the combined resistance of the molars in simple anchorage is not equal to that of the cuspid alone. The molars are invariably tipped forward and the normal harmony of the occlusal planes, so necessary to maintain is destroyed. A careful study of the alveolus and of the length of the roots and attachments of the teeth confirms common observation and practice on this point.

"The difficulty of this movement, so frequently necessary, is successfully overcome by a combination of the expansion arch with the author's well-known device, the traction screw *A* and *D*, Fig. 28.

"The traction screw is adjusted for retraction of the cuspid first. The angle of the screw is made to engage a pipe soldered to a band encircling the cuspid, while the shaft of the screw passes backward through its sheath, which has been rigidly soldered to a screw-clamp band (No. 2) firmly clamped in cement upon the first molar. The retraction of the cuspid following tightening of the nut at the posterior end of the long sheath is easily effected, while tipping forward of the crown of the anchor tooth is impossible. It must be dragged bodily through the alveolus, if moved at all, (This form of anchorage is most efficient and valuable, and is best known as stationary anchorage. It was first suggested by Dr. Barrett.)

"By combining the expansion arch with this appliance the movement of other teeth is easily carried on at the same time. The end of the arch is securely supported by being passed through a short tube previously soldered to the anterior end of the long sheath of the traction screw. Of course the same combination may be used on both sides if desirable. If not, the opposite end of the expansion arch is secured in the usual way in the sheath of the clamp-band *D*.

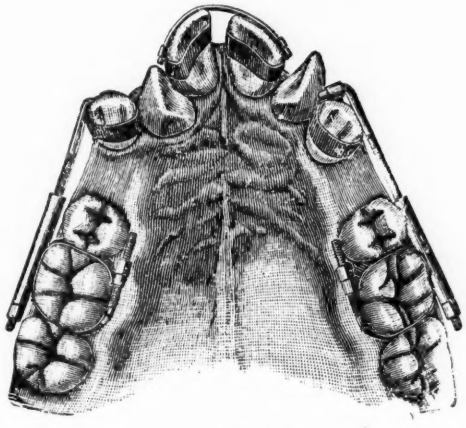

Fig. 37.

The expansion arch is attached to the teeth to be moved by means of spurred bands and ligatures in the usual way.

"It will be seen by studying this combination that we have reciprocal anchorage combined with stationary; in other words, the resistance of the force of the moving incisors is reacted to the molars, and helps to overcome the resistance of the retracting cuspid.

"This is a most valuable combination, and with it the most perfect control of that very obstinate tooth, the cuspid, is gained.

"A similar combination is extremely valuable in shortening the arch by retracting cuspids and protruding incisors after extraction of the first bicuspids, the force for retracting the incisors being received from some form of headgear upon the center of a plain threadless arch (arch *B*), the ends of which rest in tubes soldered to the ends of the long sheaths, as shown in Fig. 29, thus combining occipital and stationary archorage. With its use we may shorten the time of treatment of these cases nearly one-half, and that, too, without displacement of the molar teeth, so important to avoid in all these cases."

(To be continued.)

DEPARTMENT OF
ORAL SURGERY AND SURGICAL ORTHODONTIA

Under Editorial Supervision of

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GENERAL ANESTHESIA IN DENTAL SURGERY—WITH SPECIAL REFERENCE TO CHLORIDE OF ETHYL*

By G. W. Bampfylde Daniell, M.R.C.S., L.R.C.P. (Lond.)

Formerly Anesthetist to the Dental Hospital and College, Edinburgh, Scotland.

MY apology for presenting to you a paper is twofold; firstly, that it is good for us all, from time to time to pass in review some of the various members, their mixtures and sequences, of that powerful and highly interesting group of drugs, widely diverse, as they are, both in their chemical and physical properties, yet in their therapeutic action classed by us as one, namely, general anesthetics. The omission of this occasional review might lead us into an undesirable form of conservatism, tempting us to let pass new drugs, or better methods of giving older ones, or even some of the older ones, being out of our mental vision, might be forgotten; and, secondly, the reader, after having administered chloride of ethyl alone, and in conjunction with nitrous oxide, or ether, some thousands of times, and that largely for the needs of the dental surgeon, hopes to see from the experience necessarily gained if anything can be gleaned that may be of use or of interest to members of the dental profession.

In the study of the history and literature in connection with general anesthesia, one can not help being struck by the fact that many of the great advances which have been made in the art of the administration of these drugs bear a close relation with their use in dental surgery. Moreover, was it not a dental surgeon, Horace Wells, who first used nitrous oxide with success for the extraction of a tooth, in the year 1844? It was Morton, a dental surgeon, and a pupil of Wells, who first used ether with success for dental extraction in 1846. It was also in connection with dental surgery that the administration of nitrous oxide and oxygen, in mixture, was perfected, enabling the anesthetist to recognize the anes-

*Read before the Dental Society of the Cape Province of South Africa, 1919.

thetic properties of the former as distinguished from those of asphyxia. It has led to the employment of this mixture for major surgical operations, improved in method, I think, by the employment of CO_2 in the form of re-breathing, but I doubt if it will hold its present popularity for long in continuous anesthesia for the requirements of modern surgery without the help of a small proportion of ether—at least, that is my opinion from a practical point of view—as the anesthesia is not deep or regular enough, but I am satisfied with this present mixture, viz., NO_2 with oxygen, CO_2 and ether, having administered it a number of times.

There is little doubt that the necessities of your branch of the medical profession have taught us the use of that valuable sequence nitrous oxide gas and ether.

When we consider these facts, it will not surprise us to find that for some time past the chief activities in relation to the anesthetic properties of chloride of ethyl have been centered to a large degree in the immediate neighborhood of the dental chair.

When working in London, and later, in Edinburgh, in my specialty, there was ample opportunity of making a study of this drug, and also of seeing the work of others. As a result, I published an article in the *South African Medical Record* of December, 1904, and of January, 1905. I have reason to think that this was the most complete of its kind at the time. Since then the literature on the subject has vastly increased, to an extent, indeed, that has rendered it to not a few of us rather confusing.

The action of this drug was being thoroughly investigated, and there were several well-attended meetings of the Society of Anesthetists in London, at which I was present, when the subject of ethyl chloride was carefully gone into. I am speaking of the years 1901-2. It was then administered by spraying a full dose on to lint or cotton-wool inside a mask, or by breaking a capsule containing either 3 c.c. or 5 c.c., neither of which method appealed to me, and I think I was the first anesthetist to recommend and practice the more gradual administration, at least I had not heard of this method before. With the ideas of this method in view I devised an inhaler which, on account of its simplicity, the method of administration, and its adaptability to the employment of nitrous oxide or ether in conjunction with the ethyl chloride, is as largely used today as it was years ago.

I also had made certain slight alterations in Hewitt's wide-bore ether inhaler, so that ethyl chloride, with or without nitrous oxide, can be given by means of the small bag of the apparatus, and without any other attachment to the inhaler as fitted for ether except the small measure glass. On going through some of my original articles, in the light of more mature experience, I am surprised to find how little my opinions and advice have changed, how little my methods of administration have been modified. I am using the same inhaler—in fact, the original one. My results are perhaps a little better as the outcome of many years' experience.

Up to today I have had no trouble with ethyl chloride, either alone or its mixture or sequence with ether, neither with its use in conjunction with nitrous oxide. I have never used ethyl chloride in relation with chloroform, nor do I ever

intend to do so, as I think such a procedure would not be unattended by risk to my patient.

Neither do I like it mixed with ethyl bromide.

I must have been one of the first to give ethyl chloride continuously for surgical requirements. It was administered for forty minutes. As a result, I expect I was also one of the first to give it up.

The anesthesia was not good, neither was the condition of the patient. An uneven anesthesia, frequently of too light a type, and a general depressed condition of the patient, marked a performance I was glad to see ended.

As an outcome of this war there has been a shortage of our old favorite anesthetic nitrous oxide, so much so that I had to exercise great economy with my scanty supply, reserving it only for such special cases in which it was thought no other anesthetic was advisable. Since the beginning of the war I have only given nitrous oxide and oxygen for dentistry a few times, and continuously for a surgical operation once.

I have used ethyl chloride alone or in mixture for most short operations, both dental and surgical, and the results up to now have been uniformly satisfactory.

I crave your pardon for speaking so much of my personal experience.

We all know that the anesthetic properties of chloride of ethyl were recognized long ago. According to Kappeler, the anesthetic properties were recognized by Flourens and others, and in the year 1848 Heyfelder successfully used it as a general anesthetic in the human subject. Clover used it in 1851, and the late Sir Benjamin Richardson in 1867. We may conclude that their results were not to their satisfaction. The reasons I do not know, but we do know that at that time there was a difficulty in procuring a pure drug, and it was not until recent years that it has been taken up again by anesthetists, and later by the general body of the profession. Here I would remark that I think that, unfortunately, the enthusiasm was out of all proportion to the advantages the drug offered. But for all that, we have in ethyl chloride a valuable adjunct to our list of anesthetic agents. I say *adjunct,* for I think that in the near future its place will be found more in conjunction with nitrous oxide or ether than alone, excepting in the cases I shall shortly mention. The reason for this we will refer to later. Its chemical and physical properties are now too well known to require mention, and it is needless to remark that the employment of the purest quality obtainable is absolutely essential. A reliable, but rough, test is that of its smell if allowed to evaporate on the hand; no unpleasant smell should be detected. Hydrochloric acid is a likely impurity, easily discovered by blue litmus which should be in contact with it for at least 15 minutes. Two points of practical interest: one is that the vapor is inflammable, the other is that it has a softening effect on black rubber, but under ordinary conditions none on red rubb
Our time will not permit of many details of interest, so with your kind permission we will now pass on to subjects of practical importance to you. The first question you have to put to yourselves is the safety of this drug as compared with other anesthetics, and I think the second will be its relative available anesthesia for one inhalation after the mask has been withdrawn. In making reply to the first question, I would preface my remarks by stating that chloride of ethyl has only recently been relieved of its anesthetic apprenticeship. One ad-

ministrator has recorded thousands of administrations without one single instance to cause him alarm, and that has fortunately up to now been my experience.

A friend of mine, for instance—and at one time we worked much together—has given about 15,000 administrations alone or with ether, and with no fatality, but, be it remembered, he is an old hand at "gas," which is an excellent training for the drug under review. As time went on a few fatalities occurred, and then, a little later, rather an alarming number. My former partner, Dr. T. D. Luke, collected evidence of 22 fatalities, but details of only 17 of these are available (*Lancet,* May 5th, 1906).

We must, however, remember that this drug has been taken up by the general body of the profession in a way that no other anesthetic has ever been. A practitioner would record in glowing terms his experience of, let us say, fifty or a couple of hundred cases, as if that was any help to us. On the contrary, such reports may have done actual harm, stimulating the inexperienced—especially those who were brought up only to give chloroform—to try this rapidly anesthetizing drug in a way which the reader would almost call reckless. In reply to a question in the *British Medical Journal* of August, 1903, I took the opportunity of sounding a warning note, an extract from which I give: "As with the administration of other anesthetics, so with chloride of ethyl, caution and experience are required in its administration to produce good results in regard to a satisfactory anesthesia, a minimum of after-effects, with safety to the patient. I would strongly recommend intending administrators to see it given by an experienced anesthetist first, and to administer it under his guidance several times, and to several types of patients, before attempting to give it to his own patients. This will be an advantage to all concerned and the drug may not have to bear the blame which really may be due to faulty administration."

Ethyl chloride is rather difficult to administer because the symptoms of anesthesia come on with such rapidity, and there are no well-marked "leave-off" signs as is the case with nitrous oxide. Also, for another reason, not always so well known or recognized by administrators, namely, that the anesthesia often deepens after early signs of anesthesia have begun, so that in certain cases it is advisable to remove the mask before deep anesthesia is established, otherwise we may produce a profounder anesthesia than is desirable. When to remove the mask is purely a matter of experience. The deepening is especially noted in patients with faulty lung ventilation, and is due to continuous absorption of the vapor from the lower air passages. I first noticed it in patients suffering from chronic phthisis. In these cases more air than usual should be given. Without any special reason to the contrary, I prefer to administer the drug to patients for dental extraction in the sitting position. There is better lung expansion in this position, and there is less danger of blood or a fragment of tooth entering the larynx. We must remember that the larynx and upper air passages share with the rest of the body the prolonged analgesia, so that there is a delay of the coughing reflex. This is also not so generally recognized as it should be. There is little doubt that ethyl chloride is by no means so dangerous as chloroform in dental operations.

Ethyl chloride may prove fatal in two ways: (1) by overdose, and (2) by

intercurrent respiratory embarrassment, causing asphyxia, which may lead to cardiac arrest. It is impossible to say in what proportion of cases dangerous symptoms occur, as so much depends upon the experience of the anesthetist, the selection of appropriate cases, and numerous other circumstances. It is impossible at the present state of our knowledge to attach even an approximate death-rate to this anesthetic, but seeing how indiscriminately it has been given by the inexperienced it can not be high.

In looking through fatalities we are struck by the number of cases quite unsuitable for this drug. As instance, a child suffering from diphtheria; alcoholic and cardiac diseases; hernia operation (vomited and died of asphyxia); advanced dropsy and swelling in neck. Some of these have been fully reported, and about eight out of the 22 were dental cases. Of course, for safety, there is nothing to compare with nitrous oxide, alone, with air, or oxygen, but unfortunately the available anesthesia is so brief that it is not suitable for operations requiring any length of time, without we accept continuous nitrous oxide given by the nose. I would like, now, in a few words to enumerate some of the advantages of chloride of ethyl.

It is not unpleasant to inhale if properly given, and by means of a suitable inhaler.

The loss of consciousness is extremely rapid.

The very young, the aged, and those suffering from anemia take it extremely well, also alcoholics and heavy smokers, i.e., cases not suitable for gas.

The cost of the fluid is not high, and the apparatus is simple and portable.

It leaves little or no smell in the room.

The patient can generally leave the operating room within a few minutes after recovery, comparing favorably in this respect with ether.

There is an absence of cyanosis, so alarming to the patient's friends, who will occasionally intrude themselves into the extracting-room.

Seldom stertorous breathing; no jactitations of the limbs or body. But that which appeals to us most of all is the long available anesthesia and analgesia as compared with nitrous oxide, and on this subject I would like to dwell more fully.

In the *Lancet* of October 21st, 1906, I published a series of 400 carefully timed anesthesias, performed by myself in the dental department of the Edinburgh Royal Infirmary. The time and notes were taken by Dr. William Guy, Dean of the Dental School, and Dr. Gibbs, one of the Dental Surgeons to the department of the the Royal Infirmary. Both gentlemen happen to be skilled anesthetists, as far as dental work is concerned, if not in general work. I knew nothing of the results until the work was completed, as the papers were kept by Dr. Guy, who handed me a copy some time after. I confined myself entirely to the administrations. I gave a hundred each of chloride of ethyl, and of chloride of ethyl and gas, and the same with "somnoform." The following is a summary of the ethyl chloride:—Sex—females 80, males 19, 1 not recorded; oldest patient 52 years, youngest 8 years.

Average period of induction, 46 seconds and a fraction; longest, 105 seconds; shortest 30 seconds.

Average available time of anesthesia, 75 seconds. The longest, 205 seconds; the shortest, 20 seconds.

The amount of ethyl chloride administered—the largest dose 6 c.c.; the smallest, 2 c.c.; the average dose 3 c.c. and a fraction.

The maximum number of teeth extracted, 25, with 6 c.c. of ethyl chloride, and an anesthesia of 205 secs. = 3 mins. 25 secs. The average number, 7.24.

As to symptoms: Phonation was noticed in 13 per cent. The pupil was normal in 13; 4 mm. in 43, 3 mm. in 24, 5 mm. in 15, and 2 mm. in 4. One not recorded.

Cyanosis occurred in 3 per cent; stertor in 19; involuntary micturition, 4 (all females), one child, the others adults; vomiting 5 (on recovery), all females; hysteria on recovery, 1; struggling and excitement on going under, 3; on recovery, 4; slight movement on recovery, but complete analgesia, 4; movements while deeply under, 1.

The pathological and other conditions recorded in this series are as follows: epileptic with enlarged tonsils; specific cirrhosis of liver; anemia and faint before (color improved and felt better after operation), lips blue and cold extremities before, i.e, shock from fear; alveolar abscess; tuberculous knee; anemia, 4; cardiac disease; syphilis. The inhaler used all through was the one designed by myself, a full description of which and my method for administration first appeared in the *British Medical Journal* of April 23rd, 1904.

The patients were unselected, unprepared, and taken in the order as handed in by the nurse in charge of the waiting-room.

How does chloride of ethyl compare with nitrous oxide and nitrous oxide mixed with oxygen? The short period of induction of ethyl chloride alone, and the strikingly prolonged period of available anesthesia as compared with the nitrous oxide group are very obvious. My friend Dr. McCardie's results are confirmatory evidence, he being a well-known authority; in fact, it is largely through his writings that the introduction of this drug has today taken the place it holds in general anesthesia. Our results are slightly different—only a few seconds—due, I think, to my using a smaller bag and perhaps giving the vapor rather more slowly by means of a graduated glass tube. There is also comparative economy in the amount used. Nitrous oxide and oxygen give the best results in the nitrous oxide group, but it takes an average of 110.5 seconds for an induction, and we know that a considerable quantity of nitrous oxide is used to produce an average anesthesia of 44 seconds.

We must not lose count of the greater safety of nitrous oxide alone or in mixture with oxygen, in comparison with ethyl chloride alone. In giving ethyl chloride alone, with gas, or in mixture or sequence with ether, it is extremely desirable that the patient abstain from food for at least three hours before, and 12 hours before take the usual preliminary purge. It is not necessary to mention that all constricting articles of apparel be loosened, and a mouth-wash directed to be freely used previously. Mention was made just now that the patients were unprepared, but, seeing that the operations took place between the hours of twelve and two, all patients to be in attendance at twelve, it is presumed that the last meal was breakfast. This may partly account for the low percentage of vom-

iting, viz., 5 per cent. I find in private there is more vomiting, often due to faulty preparation and a mistaken idea that the body requires fortifying.

Doubtless the free-liver will vomit after anesthesia unless prepared a day or two beforehand. A second inhalation will generally produce vomiting. I think my former colleague, Dr. Luke, errs when he states that nausea and vomiting take place in 20 per cent; anyhow, this is very far from my experience, 10 per cent being nearer the mark.

CHLORIDE OF ETHYL AND NITROUS OXIDE IN MIXTURE

Dr. Hewitt was the first to give this mixture, which he demonstrated at the Brighton meeting of the British Dental Association. He uses his own nitrous oxide apparatus, and introduces the chloride of ethyl through an opening in the bottom of the bag, employing a thick glass tube, into which he first measures the ethyl chloride. After the patient has inhaled the gas for a few seconds, he tips in the chloride of ethyl, the valves being of course thrown out, so that there is continuous re-breathing. His results are undoubtedly good—available anesthesia about 60—but I think rather better results are obtained by employing a one or two gallon bag and giving the vapor gradually. The writer of this paper has had his glass tube accurately marked in c.c., one to five graduations, and has had the base of the tube made flat, so that it will stand. These little details seem to have been universally adopted. The advantages of this mixture are well worthy of consideration. A few patients object to the odor of ethyl chloride, even if given gradually. Nitrous oxide is therefore an excellent anesthetic to begin with, also with those who are very nervous, and have taken nitrous oxide before with satisfaction and confidence, but in whom a longer anesthesia than nitrous oxide can give is required. With this mixture, as with chloride of ethyl alone, there is a prolonged period of analgesia, and in alcoholic and neurotic subjects better results are generally obtained than with nitrous oxide alone. But there are exceptions to this, and after-effects, such as nausea, headache, giddiness, are more frequent than after gas alone, but less than after ethyl chloride given alone, and of course considerably less than after ether. As yet no fatality has been reported. My hundred cases, again condensed for this occasion, are rather complicated, for the idea was to find out as to at what period the ethyl chloride should be introduced, how much gas, how much chloride of ethyl, how long to give the mixture, etc., in order to secure the best results. The entire subject fully discussed would embrace the whole time occupied by this paper. As a result, I submit the best results are obtained by using a one-gallon bag almost filled with nitrous oxide, re-breathing from the first—no valves—for ten seconds, and the mixture for 50 seconds—60 in all. The longest period of available anesthesia, 120 seconds; the shortest 35; the largest dose 5 c.c., the smallest 1.5 c.c. There was cyanosis, slight or very slight, in 13. Stertor slight or very slight in 4. Involuntary micturition in 1. Prolonged recovery (phthisical patients), 2. Went under quietly, but violent, struggling on recovery, 2. Great excitement during administration, 1. Vomiting, 1. A breath of air given in 5 cases. Vertical nystagmus in 1 case. Excitement on recovery, but complete analgesia, 3. Marked stertor in 9. Phonation on going under, 11.

Pathological conditions under this series:—Exophthalmic goiter. Epi-

thelioma of neck. Anemia (slight). Large abscess in neck. Chronic Bright's disease, 2; and very anemic women 2.

Up to now there has been no recorded fatality. I consider this mixture exceedingly safe, and why? It may be because the vapor has not been administered in too concentrated a form, due to the bag of the inhaler having first been filled with gas, and the ethyl chloride having been inhaled gradually. But in all probability there is another and more important reason. The common result of a dose of 5 c.c. of ethyl chloride, especially if rapidly administered, is a fall in systolic pressure. The fall is ascribed to inhibition of the heart. This inhibition can be eliminated entirely by the previous inhalation of a few respirations of nitrous oxide gas, which is supposed to depress the vagus inhibitory center. When, say, five breaths of nitrous oxide are given prior to ethyl chloride, an asphyxial rise of blood pressure takes place. This can be prevented by the inhalation of a gallon of oxygen before the nitrous oxide. Thus the sequence oxygen-nitrous-oxide-ethyl chloride entails no asphyxia, no alteration of the blood pressure, and the period of available anesthesia remains the same as in the case of ethyl chloride given alone. I hold there is danger in a concentrated vapor, such as when given on lint or a sponge in a closed inhaler, or in a broken capsule, or projected through some hole in the inhaler directly from a cylinder. We know that a concentrated dose of chloroform will kill with astonishing rapidity, and the strength of chloroform vapor is being reduced less and less, with satisfactory results, and it is now understood that chloride of ethyl has something of the same physiological effects, so that it is not unreasonable to suggest, as I have years ago, that the drug should be given gradually. It can not be so lethal as chloroform, otherwise why should we be able to give it with nitrous oxide without air, and in such doses? The whole point of my argument is, give it gradually with air or with nitrous oxide gas; do not overpower the cardiac and respiratory centers with too concentrated a dose. Being highly volatile and readily absorbed, this is a source of danger.

ETHYL CHLORIDE AND ETHER, MIXED

Although, as mentioned before I have not as yet had any cases of respiratory or cardiac troubles with ethyl chloride given alone, yet, on the score of caution, I have for some years been in the habit of adding a small quantity of ether to the ethyl chloride in the small measure glass previously described. This especially in feeble subjects and when it is necessary to give a large dose of ethyl chloride. By this means we employ the stimulating properties of ether much in the same way as it is used in the C.E. or A.C.E. mixture. Although mixed, the evaporation of the two is unequal, and this is a distinct advantage. The chloride of ethyl vapor, predominating at first, produces rapid loss of consciousness, followed by anesthesia, and later, when the depressing action of the ethyl chloride may become manifest, the stimulating action of the ether will come into play, for it is towards the latter stage of anesthesia that there is the increased proportion of ether in the vapor, the intake of which is favored by the increasingly deep and more frequent respirations. I fully described this method in the *British Medical Journal* some years ago.

The anesthesia is very good, and the patient's condition is more in the direc-

tion of stimulation than otherwise. Of course this method admits of great variety of effects, according to the proportions of the two drugs used. If much ether be added, the induction is longer and the patient may complain of the smell of the ether. Nitrous oxide can first be given, and then the mixed ether and ethyl chloride, and thus administered patients do not complain of the smell of ether.

Another method of giving the mixture in order to produce a true mixed anesthesia is by the employment of an ordinary Clover's inhaler, with the measure glass attached to a large tap on the angle mount, or the wide bore ether inhaler, designed by Hewitt and modified by myself, for the purpose of being able to give in a simple way chloride of ethyl or nitrous oxide or oxygen. With this mixture we are enabled to get an available period of anesthesia varying from two to three minutes, and even longer.

About half an ounce of ether is put into the ether container, and about two and a half c.c. of ethyl chloride into the measure glass, which is attached to the tap. The latter is gradually introduced, and then, when signs of unconsciousness begin to be shown, the ether is turned on, and as quickly as possible.

THE ETHYL CHLORIDE-ETHER SEQUENCE

This is nothing more than a continuance of the anesthesia mentioned just now with ether alone, in the usual way. It has largely supplanted the gas and ether sequence because the patient is more rapidly plunged into forgetfulness; there is little or no cyanosis, less congestion of the throat and upper air passages, and therefore less secretion from the buccal mucous membrane—this latter of interest to those working in the mouth and throat. There is less secretion of saliva. The apparatus is more portable and convenient to manipulate. It is of course used when a longer time is required than the above-mentioned drugs or their mixture can give. The available anesthesia furnishes ample time for the operator to clear both upper and lower jaws of teeth and roots. As with ethyl chloride alone, or its mixtures with ether, the patient is prepared the same as for a surgical operation. I sometimes think that if convenient to all parties concerned, dental extraction of any magnitude should be performed in the patient's own house, or in a nursing home, as there is less risk of the patient contracting some pulmonary complication; also, these long dental operations entail often a considerable amount of shock, so that a delicate patient is better put to bed at once, and, further, there is less chance of vomiting if the patient be kept quiet for some time.

THE LATE EFFECT OF THE HARELIP AND ITS CORRECTION BY A NEW OPERATION

By J. L. Aymard, M.R.C.S., L.R.C.P.

Late Plastic Surgeon, Cambridge Hospital, Aldershot, Southampton, England; Plastic Surgeon and Ear, Nose and Throat Specialist to the Queen's Hospital for Facial Injuries

THE photographs of this young girl are representative of a series of similar successful cases, and present a condition familiar not only to surgeons but the general public—the tightly stretched upper lip giving the appearance of the underhung jaw, the absence of the red margin, and the loss of the proper contour in both dimensions, together with the absence of the philtrum. The nose in such cases is very frequently flattened and deflected, and nasal stenosis a necessary accompaniment. In young ladies, especially, the appearance is detrimental

Fig. 1. Fig. 2.

Fig. 1.—A typical side view before operation, giving the appearance of an underhung lower jaw.
Fig. 2.—Side view after correction by operation.

to marriage, and as far as I know there are no cases on record in which the difficulty of correction has hitherto been overcome.

The nasal condition associated so frequently with these cases is extremely complicated, and many considerations must be taken in view before any attempt is made to correct the same. A study of the correct anatomy of these parts, published by me in the *Journal of Anatomy*, will assist considerably, but I would

lay it down as a law that the preliminary correction of the nasal trouble and the lip must be made at the same time. To correct the position of the nose it is frequently necessary to readjust the nasal crest, and the complete exposure of the floor of the nose is often essential. Although the operation as illustrated looks comparatively simple and some may be tempted to try it for the sake of kudos, I would warn such surgeons to make themselves familiar with all the necessary adjuncts to success, such as the correct amount of overcorrection, the freeing of all the tissues in the neighborhood and the supporting sutures, and many other details known to the plastic surgeon. It is obviously a temptation to perform any operation for the restoration of the lip, and then to send the case to the nasal

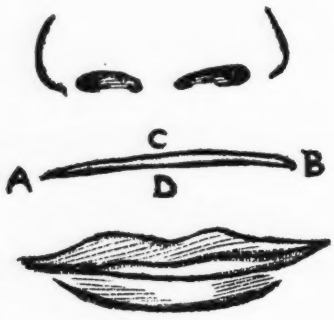

Fig. 3.

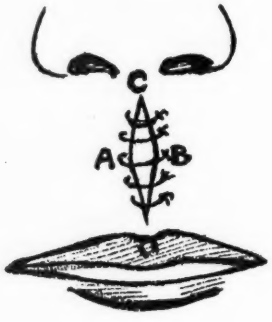

Fig. 4.

Fig. 3.—Shows the incision made from the inside through the whole thickness of the lip up to the inner surface of the skin.

Fig. 4.—Shows the incision sewed up in the opposite direction. The deep supporting sutures are not shown, nor the incisions for freeing the surrounding tissues.

surgeon to restore the nose, but the unfairness of such a procedure will be obvious when I explain that if the lip be repaired separately the subsequent operation to expose the floor of the nose would so stretch the lip that it would break down even after the lapse of a considerable period. In the near future I hope to publish a paper on the whole subject of harelip and cleft-palate, which I think may throw considerable light upon this hitherto somewhat unsatisfactory subject. The period preferable for such operations I would place from six to four years of age.

DEPARTMENT OF DENTAL AND ORAL RADIOGRAPHY

Under the Editorial Supervision of

JAMES DAVID McCOY, D.D.S., Los Angeles—ROBERT H. IVY, M.D., D.D.S., Milwaukee

B. FRANK GRAY, D.D.S., San Francisco—C. O. SIMPSON, M.D., D.D.S., St. Louis.

It is the object of this department to publish each month original articles on dental and oral radiography. The editors earnestly request the cooperation of the profession and will gladly consider for publication papers on this subject of interest to the dental profession. Articles with illustrations especially solicited.

RADIODONTIC EXAMINATION WITH SPECIAL REFERENCE TO LOCALIZATION OF UNERUPTED TEETH*

BY CLARENCE O. SIMPSON, M.D., D.D.S., ST. LOUIS

THE evolution of modern orthodontics from the pioneer operations, the scientific study which has been applied to this development, and the wonderful transformations produced by orthodontic treatment, is a source of inspiration and pride to observing members of the dental profession. Orthodontists deserve the credit of contributing to the profession their observations on the basic principles of occlusion, and the far-reaching effects of malocclusion which have markedly broadened the conception and improved the technic in most branches of dental practice. No more striking exemplification of the favorable results of concentration in a limited field of endeavor is evident than in the practice of orthodontia.

It is unnecessary to offer a plea before this society for the advantages of specialization since all of you have chosen this course. Your personal experience has strengthened your convictions, and your accomplishments are abundant proof of the efficiency of limited practice. As practitioners of one of the first established specialties of dentistry you are asked to consider what claim radiodontia, one of the recent specialties, has for recognition, and of what service it may be to you. While a few orthodontists have done notable work in radiodontia, most of you have been in the same position as the general practitioner of dentistry in this matter. Until recently the dentist, orthodontist, and exodontist have referred radiodontic examinations to a general radiographer of medical or laboratory training, who attempted to dignify or mystify his vocation by publicly proclaiming himself a disciple of Professor Roentgen, but attached little importance to dental radiography. The other alternative was being exploited by the energetic optimistic salesman into installing radiographic equipment, and endeavoring to become proficient in the operation of it, or worse, delegating the work to a

*Delivered before the Nineteenth Annual Meeting of the American Society of Orthodontists, St Louis, Mo., March 10, 1919.

lady assistant. Rarely has either of these methods proved satisfactory, or given the dentist or orthodontist the adequate service.

The general radiographer is handicapped by a lack of familiarity with dental operations, and has such a volume of diagnostic and therapeutic work that dental examinations can not be given the deserved attention. The dentist being inexperienced in radiographic diagnosis has not insisted upon better service as have the physician and surgeon, and service is seldom more efficient than the demands

Fig. 1.—The usual method in attempts to determine the location and position of unerupted teeth. The small film is a lingual view through the bicuspids, and the larger film was retained between the teeth while the rays were directed downward and backward through the base of the nose; the latter producing only a lingual view with inferior detail of the incisors, and a vague conception of the bucco-lingual position of the bicuspids.

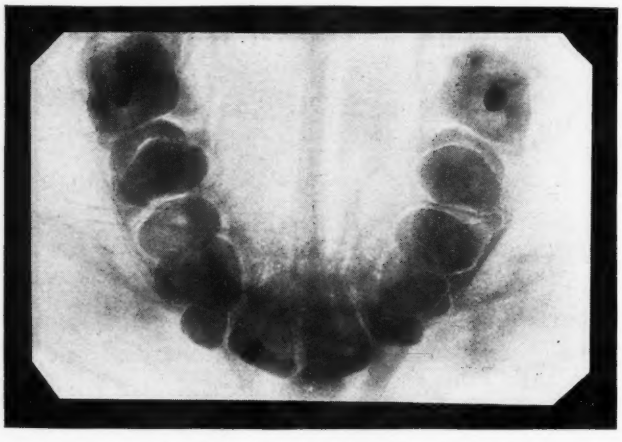

Fig. 2—A true occlusal view of the same arch in which the bucco-lingual and mesio-distal relationship of the teeth are shown. This in connection with the lingual views to determine the distance of erupting teeth from the occlusal plane supply data for localization.

made upon it. If the dentist succumbs to the propaganda of the manufacturer and installs radiographic equipment, he will be obligated to an investment and maintenance expense for which he probably will not be directly compensated in fees, and he will be compelled either to utilize an additional room or convert his operating room into an equipment display. Unless he will devote equal time and study given to any exacting technic, his results will be inferior, and if he attempts to train an assistant for the entire operating he is likely to complicate the situation and cloud the diagnosis.

Fig. 3.—A partially developed malposed bicuspid, through which the lingual view parallels the long axis, leaving the observer at loss as to whether the crown is presented buccally or lingually.

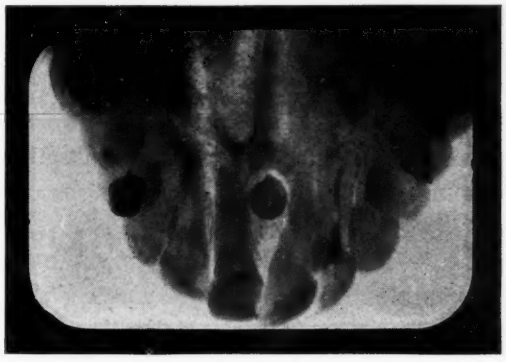

Fig. 5.—A supernumerary, the development of which resulted in traumatic devitalization of the left central. Although it appears to be wedged between the centrals, there is uncertainty as to the form and exact location.

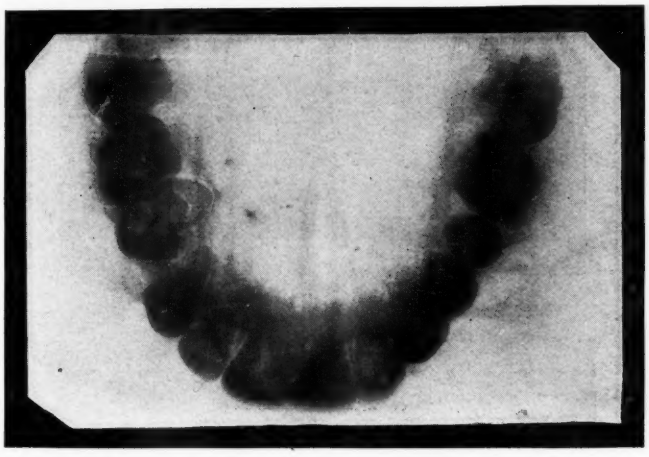

Fig. 4.—This occlusal view discloses the position, and the bucco-lingual location which could not be determined from the lingual view.

Fig. 6.—This aspect facilitates surgical procedure by showing it to be rudimentary in development and lying to the lingual of the central incisors.

The choice of ways and means is a matter of individual opinion, but the radiographic results of different methods are not influenced by personal prejudice, they are vivid records always subject to comparison. Discrimination of radiographic films and plates is developed by critical study of them; the average standard is far below existing possibilities, and nothing short of the maximum information obtainable should be tolerated. Dental and oral radiography has been a neglected and undeveloped field, and the orthodontist has not received the proper cooperation in radiodontic examinations, nor sufficiently utilized this indispensable adjunct to orthodontic treatment. In view of the development of any art or science from specialization or intensive application, it is a logical con-

Fig. 7.—Lingual view of secondary dentition which does not establish the bucco-lingual relationship of the teeth.

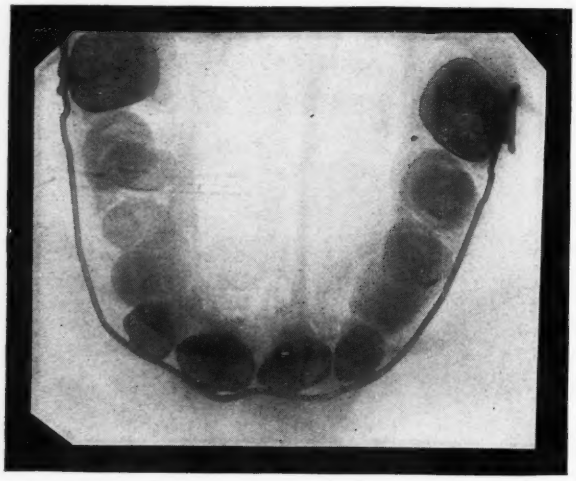

Fig. 8.—Occlusal view which completes the localization of unerupted teeth in Fig. 7.

clusion that the limited practice of radiodontia will produce decided progress in dental radiography.

Some orthodontists believe that they can photograph their patients to best show improvements in facial contour from the correction of malocclusion, but excepting stereophotography, it seems more of a conceit than a necessity. It is possible that the professional photographer would not obtain the striking "before and after taking" effect including coiffure, sartorial embellishment, and ex-

pression, sometimes observed in photographs of these cases, but with proper instruction he should supply uniformly accurate records. The orthodontist with sufficient practice to occupy his time who assumes radiodontia is likely to appear in the same aspect, and secure results similar to the busy dentist who attempts orthodontia. If to orthodontics, art, engineering, and prophylaxis, is added photography and radiography, we may tax our versatility and become a "one-man organization," rivaling the activities of the drummer in a "jazz" band. During the early development of dental specialties necessity may have compelled lax restrictions in limited practice, but in the future combinations of orthodontia,

Fig. 9.—Lower bicuspid regions of same case as Figs. 7 and 8.

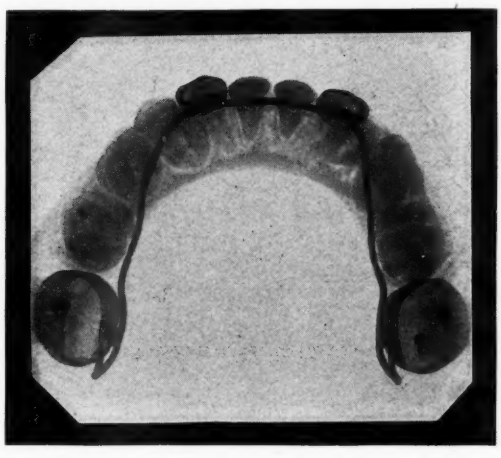

Fig. 10.—Occlusal view of entire lower arch, which establishes the relative location of the erupting teeth in Fig. 9.

exodontia, periodontia, or radiodontia, may arouse suspicions of commercialism and a questioning of altruistic motives.

The fundamental requirements of radiodontic examination for the orthodontist are: determining the absorption of deciduous teeth, and the presence, location, position, mesio-distal diameter of crowns, and degree of development of the permanent teeth. This does not constitute a formidable number of requirements, but in view of the limitations in radiographic technic, and the difficulty of securing immobility and cooperation from young patients, it demands

qualifications which combine speed, legerdemain, and hypnotism. During secondary dentition every child should have a radiodontic examination at least once each year to determine the indications for exodontic or orthodontic treatment. The orthodontist who ignores the opportunity of supplementing clinical observation and physical examination with routine radiodontic records may be classed with the dentist who makes every diagnosis by subjective symptoms and swelling.

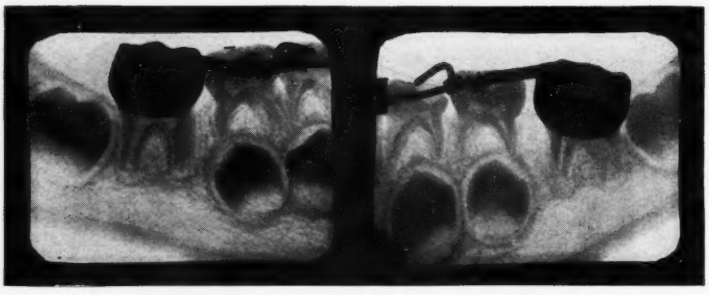

Fig. 11.—An excessive application of intermaxillary force in a Class III malocclusion which has resulted in a distal inclinaton of the first molars.

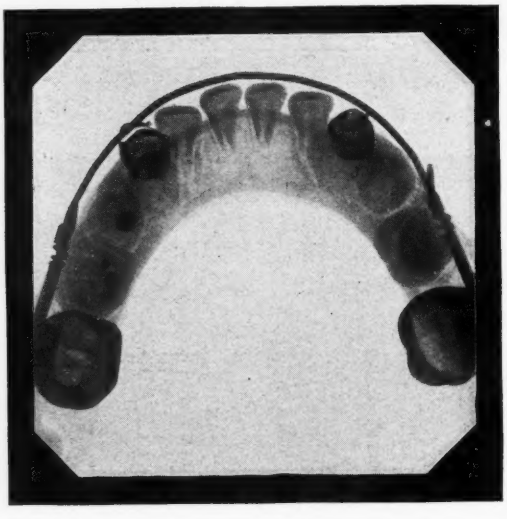

Fig. 12.—Occlusal survey of the case in Fig. 11.

Decalcification of deciduous teeth may not progress normally, and radiodontic examinations will indicate the removal of deciduous teeth which are retaining or deflecting the successors. Caries or pulp involvement often suggest the removal of deciduous teeth which radiodontic examination shows should be retained for maintenance of space to accommodate the arrested development or delayed eruption of the permanent teeth. With a difference of opinion which is characteristic of authorities upon any subject, tables for the period of eruption not only present a latitude of two or more years, but vary quite materially. A discrepancy of two or three years between anticipation and manifestation is sufficient to wreck the occlusion. Prophylaxis, the ultimate in operative dentistry, is also applicable to orthodontia.

The presence or absence of permanent teeth sometimes becomes of critical importance to the orthodontist who has applied treatment with a sublime faith in nature "running true to form" and supplying the normal quota of teeth. The congenital absence of teeth is not sufficiently rare that it may be disregarded and the early knowledge of it, secured through routine radiodontic examinations, would modify treatment and avoid chagrin and humiliating explanation. Lamentably, too often radiographic examinations supply little exact information be-

Fig. 13.—A thorough inspection of the maxillæ which in connection with the history conclusively proves the congenital absence of a lateral incisor. To exclude the possibility of a migratory tooth by the elimination process of former methods requires several lingual views and extraoral plates.

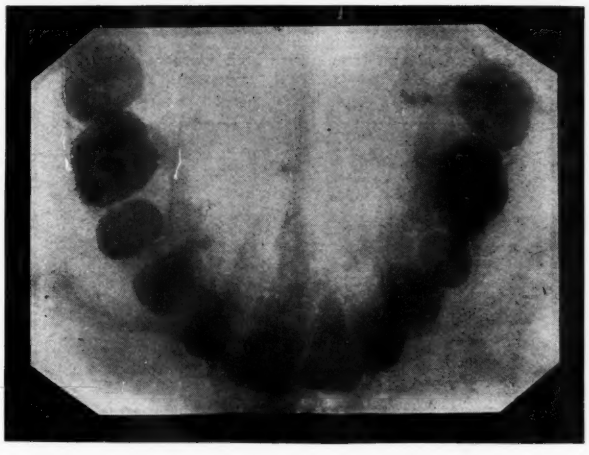

Fig. 14.—Congenital absence of two upper bicuspids.

yond establishing the presence of teeth, which is inadequate for rational orthodontic procedure. The relative location and position of unerupted teeth must be determined to form a prognosis and choose methods to assist the teeth into normal occlusion. The interpretation of a plane, radiographic film, or plate, is misleading in direct proportion to the divergence of teeth from normal position. Textbooks which are often as amusingly antiquated as ladies' fashions of a for-

mer period, lamely advocate stereoradiography, for localization of malposed teeth. Stereographic intraoral films are difficult to produce under favorable conditions, which so rarely are presented by children. When obtained, they only add perspective, with its possibilities of illusion, and the disappointment in at-

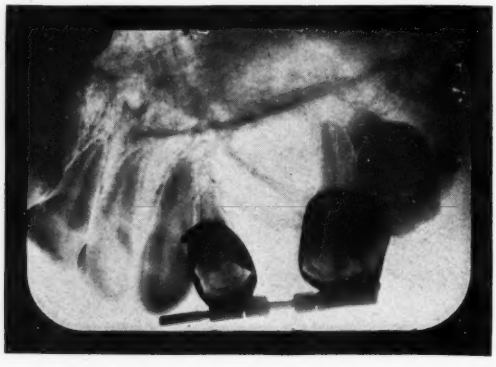

Fig. 15.—Radiographic examination neglected while space was retained two years for a bicuspid which did not exist.

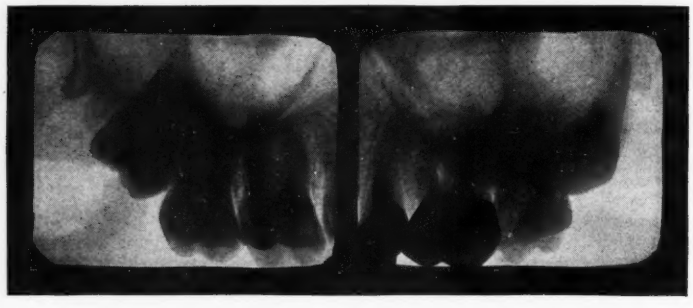

Fig. 16.—Two upper malposed unerupted third molars, which were suspected of being the source of reflex disturbance.

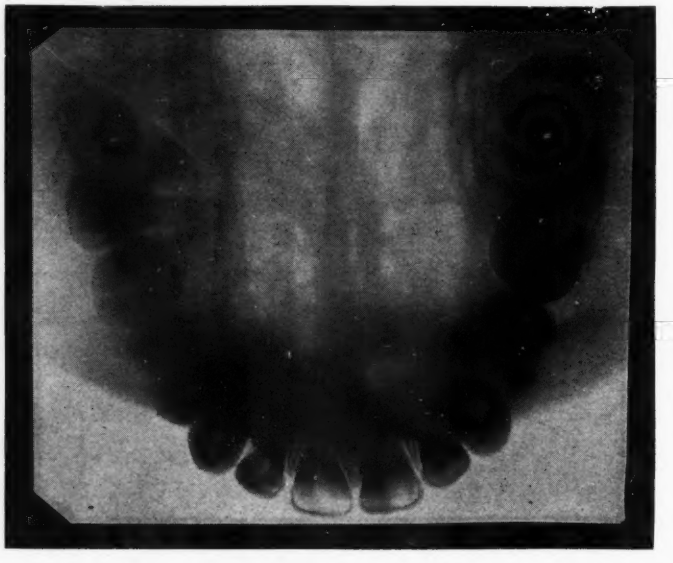

Fig. 17.—This occlusal view of the third molars in Fig. 16 establishes the location and position for the exodontist.

tempts to distinguish the relative position of small objects in comparative proximity. Precision in determining form, and location is attained by viewing object in two or more planes of the three dimensions. In the standard technic for intraoral films, the rays are directed from the buccal or labial at a variation of 45 degrees in a mesial or distal aspect and at a variation of 25 degrees toward the vertical or horizontal plane. This is often insufficient to ascertain the outline of malposed teeth and totally inadequate for localization.

The method herewith proposed is the extension of the vertical—horizontal

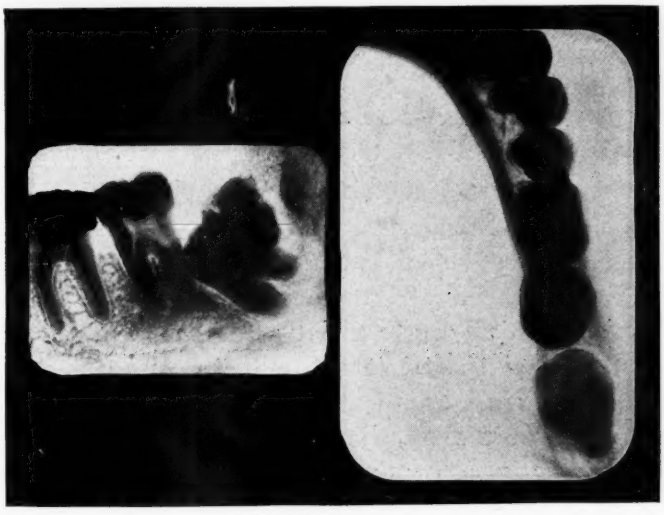

Fig. 18.—A clinical diagnosis of "bone tumor" was made, and an alleged operation performed seven years prior to this examination, which determines location of an odontoma from a lower third molar.

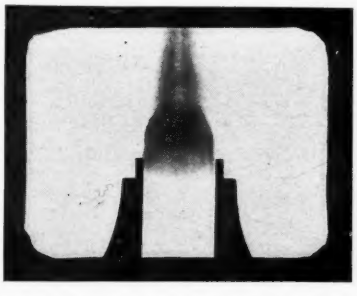

Fig. 19.—Illustrates the accuracy with which the size is recorded by a fine focus tube at a long film target distance. The calipers adjusted to the exact width of the tooth rest on the film, while the tooth is suspended one inch above.

arc from which the rays are directed, from 25 degrees to 90 degrees in either dental arch, permitting various views from both lingual and occlusal aspects. To a limited degree this method has been used for the mandible, but no mention has been observed of its use for the superior maxillae. The technic employed is the use of films slightly larger than the arch, placed on an aluminum base to maintain a flat surface and prevent distortion. The film pack is carried distally to the anterior border of the ramus and the teeth occluded on the metal and pack to retain it. For the lower arch the patient is posed with the head thrown backward to a horizontal position permitting the rays to be directed at right angles to the occlusal plane of the arch. For the teeth in any particular region a smaller

film is used and the rays directed parallel to the long axis of the teeth. For the upper arch, with the head in a vertical position, the rays are directed downward through the parietal bones, slightly anteriorly to a perpendicular of the film for the entire arch, or directed parallel to the long axis of any tooth. This produces an occlusal view which in connection with a lingual view determines the location, position, and the approximate form of the teeth, comprising highly important data for the orthodontist. Young patients are especially adaptable to this technic since it eliminates the digital retention of the film and the discomfort to the soft tissues in the floor of the mouth. An appeal to the competitive spirit by reference to a mythical little girl who accommodated a much larger film, will secure a startling buccal capacity, and the average child, from prehensile instinct, will bite even when instructed to the contrary. The same care must be exercised in making the examinations through the skull, as in sinus examinations, limiting the exposure to the minimum to obviate the danger of alopecia.

The opportunity to ascertain the size of the secondary teeth before eruption should be of great practical value to the orthodontist, and this may be accomplished with great accuracy by radiographic records. With a fine focus tube, a target film distance of 18 inches and the tooth one inch from the film, the image is not enlarged to any practical degree, about $\frac{2}{10}$ of a millimeter. The mesiodistal diameter of each tooth may be determined by the occlusal view, and the permanent arch charted long before eruption of the teeth. This permits preliminary treatment to accommodate the secondary dentition, and is of special value in securing and maintaining space for the delayed eruption of one or more teeth.

These details are presented for the consideration and discussion of this body, to obtain an appraisement of the practical value of thorough radiodontic examinations for the orthodontist, and to stimulate suggestions for improvement in this phase of radiodontic practice. Cooperation between practitioners of specialties so intimately related as are those of dentistry, is mutually advantageous and a potent factor in the progress of dental science. Radiodontia is in a plastic state of its development and will conform to the demands and ideals of the dental profession; may it not have the inspiration of your confidence, constructive criticism, and guidance?

DISCUSSION

Dr. R. J. Wenker, Milwaukee, Wis.—In connection with this discussion of localization of impacted teeth, I would like to report a case of unusual interest.

In April, 1916, an exceedingly interesting case came into my hands in the person of a dentist about 40 years of age, who had an impacted upper third molar operated upon three successive times within a period of three days, and in which the tooth had become lost in the soft tissues at the first operation. The tooth was originally located in a perpendicular position, immediately distally of the second molar, and completely covered with soft tissues. The first step taken by the surgeon in charge of the case, was to secure a good x-ray. Local anesthesia was used and in the attempt to tip the tooth out of the socket by means of elevators, it became lost in the soft tissues posterior to and above its original position. This operation was performed at the surgeon's office, and immediately following the accident, the patient was transferred to the hospital, and in the afternoon of the same day under ether anesthesia a futile attempt was made to recover the tooth. After a lapse of one day, another x-ray was taken and the tooth was indicated at a point lingually and slightly anterior to the upper extremity of the coronoid process of the

Fig. 1.

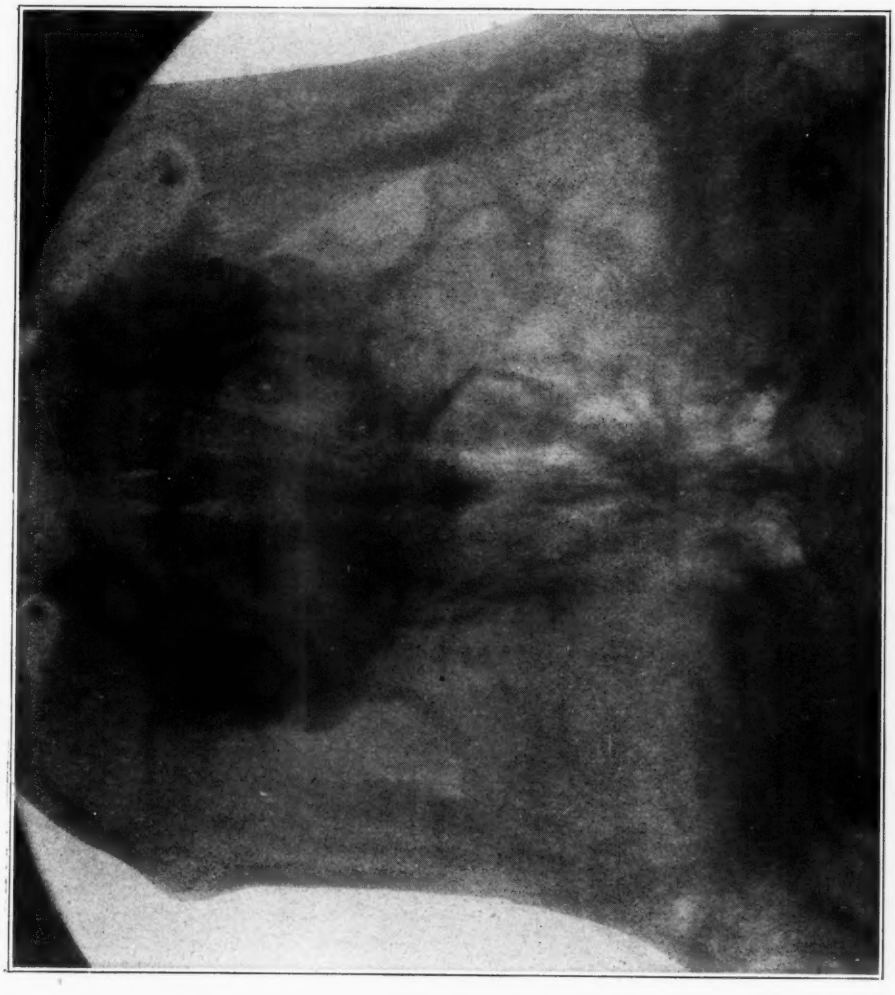

Fig. 2.

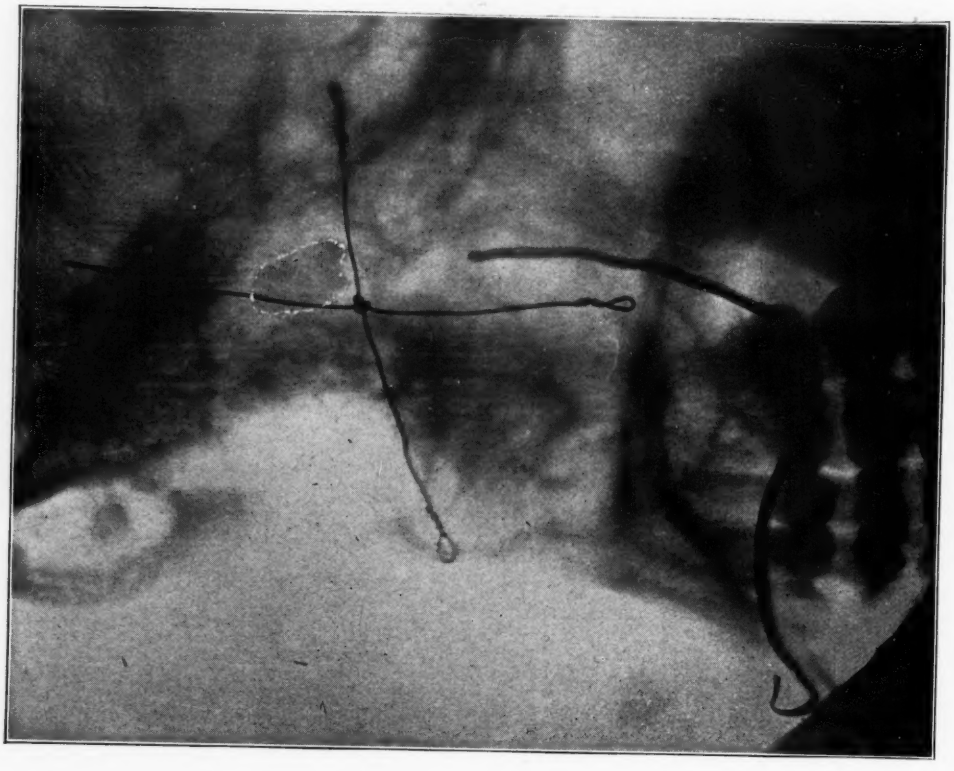

Fig. 4.

Fig. 3.

mandible. The same day another futile attempt, under ether anesthesia, was made to recover the tooth.

Three days after the last attempt, I was called in to take charge of the case. My first effort was made to combat the infection. The face and side of the head were extensively swollen, the pulse was rapid and very irregular, and the temperature was 102°.

The upper margin of the swelling was sharply outlined by an abrupt termination along the line of the bony attachment of the temporal muscle. This gave me the suggestion that the tooth was pushed beneath this muscle, which in my subsequent examination proved true.

The infection was combated by frequent irrigation of the wound back of the second molar and up as high as the irrigating tube could be extended without extreme pain.

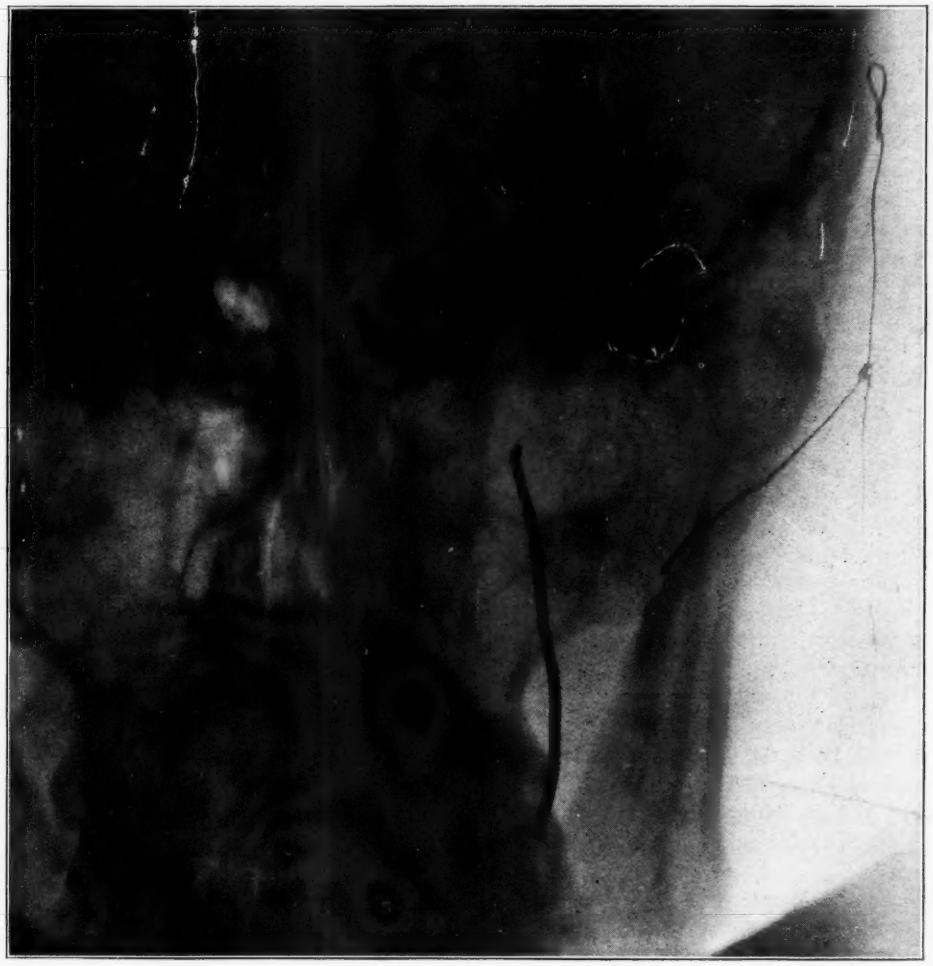

Fig. 5.

This irrigation was the first the wound had received, although six days had elapsed since the first operation. Besides the irrigation very hot boric acid packs were applied continuously, day and night, except while sleeping, for two weeks. At this time the patient was in a satisfactory condition to take to my office, and take x-rays to locate the much sought for tooth. Fig. 1 is an illustration showing the original position of the tooth. Fig. 2 is an anterior-posterior view and is my first effort to locate the tooth. At this time it occurred to me that a silver wire inserted as high as possible into the wound, and ligated to the buccal surfaces of the bicuspids and molars would be some assistance in locating the tooth. Fig. 3 is a side view with wire inserted. Note that the tooth is mani-

fest in the lower and anterior portion of the temporal fossa, beneath the zygoma and about one inch posterior to the anterior border of the external orbital margin. The following day this view was repeated by reinserting the wire in the mouth wound, and using Fig. 3 as my guide, a cross was made of silver wires and located on the outside as nearly over the tooth as possible. This view is shown in Fig. 4. In Fig. 5 we have an anterior-posterior view with the same wires in place. In the two latter figures, the tooth was outlined with a lead pencil to bring it more clearly to view.

In the removal of the tooth, sixteen days after taking charge of the patient, ether anesthesia was used and a skin incision was made above the zygoma and just anterior to the hair line. By blunt dissection the temporal muscle was exposed and split. Then a search for an hour and a quarter was made for the tooth. After nearly despairing in my effort to find it, I recalled that the tooth shows a slightly different position in Figs. 4 and 5. This was probably due to movement of the temporal muscle over the incline formed by the external surface of the skull beneath the zygoma where the tooth was lying. The muscle movement caused the tooth to move to a more anterior position into a deeper part of the fossa. I therefore placed my index finger into the mouth wound, and strained and searched until I located the tooth with my finger tip, and while maintaining this digital contact the tooth was removed with a pair of hemostats through the external incision.

There must have been some leakage through the gum tissue, admitting infection to the impacted molar to explain the existence of caries in the crown of the tooth. This cavity on one side of the tooth and a hook on the end of the root on the other side, helped to hold the tooth in each new position as it was pushed up into that location. I might add that it is a very easy thing to lose a tooth in the manner and location that this one was lost. If you do not believe it, try it. I have tried it by making a free use of elevators on this type of impaction and came very near losing a number of them in the same way. Such a tooth can easily travel between the pterygoid muscles on one side, and the ramus of the jaw part of the way and the temporal muscle on the other side until it reaches that position. It did not pass through any muscle, but between muscles and other structures, and it is an easy place to get a tooth into. Only a slight amount of pressure is necessary to push it there.

Dr. George B. Winter, St. Louis, Mo.—I have enjoyed the reading of the paper of Dr. Simpson very much, and desire to compliment him on the able manner in which he has presented the subject. The diagnosis of impacted teeth is a very important matter. I was particularly interested in the slides of the case showing the occlusal plane of the tooth without any root formation.

It is not uncommon in a case of impaction of a lower third molar to have complete lingual displacement. When the x-ray operator, following a certain procedure as to position of both the tube and patient for impacted lower third molars, determines that the tooth is lingually displaced, another film should be inserted, and an odontograph made as when radiographing a superior third molar. In following this method, all of the root of the tooth is brought out in the picture, and the entire detail of the root formation is presented.

I have seen many cases of impacted teeth where the pressure was on the distal surface of the second molar to such an extent that there was no contact between the second and third molar. In addition, in such cases there is usually a destruction of the peridental membrane on the distal surface of the third molar, and it is not uncommon to find an exposure of the tooth pulp on account of the pressure caused by the impacted third molar.

The accident in the case of a superior third molar as presented by Dr. Wenker is of common occurrence. It occurs when the lower third molar is impacted and the entire lingual plate has been destroyed, with a pathologic condition prevailing. Where any pressure is created buccally on the third molar and the lingual plate has been destroyed, the tooth is pressed lingually into the soft tissue. The same condition is presented with the upper third molar where there is an impaction pressing on the distal surface of the third molar.

When the elevator is applied between the second and third molar, there is a liability to push the tooth into the soft tissue. The liability of such an accident occurring may,

however, be minimized by excising a part of the buccal osseous structure and straightening the tooth sufficiently with an elevator to allow a good adjustment of narrow-beak forceps, but care should be taken that the beaks do not strike the crown.

Dr. E. G. Weeks, Saginaw, Michigan.—A year ago Dr. Kells gave us a very beautiful paper. The doctor, as I told him personally, went into this too deeply. He used a tube stand, home made; it has stereoscopic adjustments and all movements necessary to produce beautiful radiograms, as you gentlemen know.

When Dr. Kells finished his paper, one of our members finished the evening in discussing terminology, and we knew, perhaps, after it was all over that telegraph, telephone, photograph and several other "grafs" came from some Greek "graphs," but we did not get a thing that Dr. Kells wanted to impart to us. Dr. Kells went at the localization of impacted teeth stereoscopically. I told him then he could locate them much more easily by taking two views of the same location from two different angles. Now, we all strive to improve on our work, and if we feel we are original in finding some way of getting better results in an easier way than the other fellow does, we should be willing to give to each other these ideas as soon as possible.

I did not know, when Dr. Kemple asked me to discuss this paper of Dr. Simpson's, just how the doctor went about to locate or localize the teeth, and I felt that he was going to give us something along Dr. Kells' idea, and I made up my mind to bring on a few slides to show why I thought my way the best. I wanted to "beat some one to it."

Dr. Simpson invited me out to his office last Saturday, and what do you know? Here I found my idea—at least I thought it my idea—as I had never seen it before, in use by Dr. Simpson. I saw many beautiful radiograms. Dr. Simpson is taking great pride in his work and deserves much credit.

I must say that I do not agree with the doctor when he says "we will become a one-man organization, rivaling the drummer of a jazz band," if we take our own radiograms and photographs; why doesn't he also add, taking impressions?

Now, why do we take impressions? I have heard one or two say, "oh, just for an impression on the parent." Well, I think those fellows too big and bright for our bunch; some of us are not so large. We must study our cases from every angle inside and out; we must get histories, not only of today, but of early conditions as far back as birth, and even before, in some cases. If this is so, we take impressions of all the structures we can get in the plaster. Years ago this was enough; today it isn't. We have seen the mistakes in the guesswork of our older men and we must profit thereby; missing supernumerary, impacted and malposed impacted teeth. We must know not only that these conditions exist, but their exact locations.

I have heard an efficiency man of some note make the statement that "an operator who does anything away from the chair that can be done by his assistant is as far behind the times as is the business man who writes his letters in long hand." I believe him. We take impressions of the mouth, give them to our assistant and she does the rest. Now, isn't it our duty to take the radiograms and photographs and let her finish them? It can all be accomplished in a very short time, and we can sit down at our study table, first study the teeth as they occlude, then, if any teeth are missing, we can reach over to the x-ray light box and see at a glance just what condition we will have to combat.

I believe that every case that presents itself for examination should be examined, not glanced at and shot at in the darkness of guesswork.

I have a few slides and will show them at this time.

Dr. V. E. Barnes, Cleveland, Ohio.—The slides that have been shown in connection with the localization of teeth are very interesting, and the localization of the cuspids is very good. I have recently devised a method for localizing molars which is so simple and logical that I have been amazed that none of us discovered it before.

This is a very good picture in the negative, and a fairly good one in the slide.

In taking these pictures to localize the upper and lower third molars, we should see as great an area as possible. We should take them showing the angle of the jaw, the character of the bone, as well as the position of the roots in relation to one another and to inferior dental canal. In our work it is not so necessary to know the length of the molar, but

it is essential to know whether the third molar has room to erupt back of the second molar.

This is the case of a child showing the normal eruption of third molars. In impaction cases in nervous people you will find the roots of the third molar resting apparently mesially or upon the inferior dental canal, with consequent pressure on the nerve. An abnormally small picture does not show the relation of the teeth roots to this nerve.

Here is a case of impaction where expansion was made in such a manner as to produce no posterior movement of the molars, yet we had impaction of third molars at 13 years. You might work until doomsday and not have the third molars satisfactory. This is a case for extraction of the second molar, and in saying so I do not want to convey the idea that we advocate the extraction of second molars, for in the majority of cases we do not.

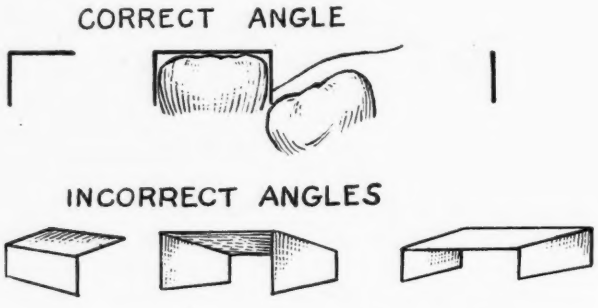

Fig. 1.—A thin (.003 inch) indicator placed over a tooth and between other teeth to show angle of rays.

Here is the relation of the teeth to the inferior dental canal. It shows the bone as well as the right angle affecting the jaw in an obtuse angle. We want to know many times whether a tooth is lapped over other teeth.

Speaking of the radiographer, I want to say that a busy orthodontist has no time to bother with x-rays. The orthodontist should engage the services of a radiographer who knows how to take radiograms properly. I conceived the idea of using metal between the teeth, allowing it to extend over the top of the tooth, so that we had in the picture, if correct, a perfect right angle view. If the picture were distorted or taken off at an angle (illustrating) we would see a broad surface and not a straight line. If the radiographer found the broad surface on one side or the other he would take the picture over. I had to know that the picture was taken at a right angle to determine whether the tooth was overlapping or not.

Fig. 2.—Sixteen years. Room for third molar eruption.

Fig. 3.—Thirteen years. Third molar impaction.

ABSTRACT OF CURRENT LITERATURE

Covering Such Subjects as

ORTHODONTIA — ORAL SURGERY — SURGICAL ORTHODONTIA — DENTAL RADIOGRAPHY

It is the purpose of this JOURNAL to review so far as possible the most important literature as it appears in English and Foreign periodicals and to present it in abstract form. Authors are requested to send abstracts or reprints of their papers to the publishers.

Mandibular Bone-Grafts. C. W. Waldron and E. F. Risdon. Proceedings Royal Society of Medicine, London, 1919, xii.

In the early treatment of mandibular compound fractures with loss of bone substance, persistent efforts should be made to keep the mouth as clean as possible by frequent mouth washings and irrigation of pockets and sinuses. All sinuses should be freely drained and any attached comminuted fragments should not be disturbed until they become separated and remain as sequestra. Displaced fragments should be corrected and held by dental splints for two months or more. Teeth too near the line of fracture or those predisposing to infection of the wound should be extracted, but those which will be of service in immobilization of the parts when the graft is placed should be preserved. The date when all external and alveolar sinuses have definitely healed should be noted as no operative procedure should be undertaken until at least six months have elapsed after the complete disappearance of all inflammatory processes.

At least a week before the operation the dental splints should be cemented to the teeth in order that the mucous membrane of the mouth may become accustomed to them. The anæsthetic used is ether oil administered by rectum and ether administered intrapharyngeally through a nasal tube. After the field has been prepared with ether and iodine, a sterile dental rubber dam is fixed to the cheek and lower lip with adhesive. By turning this upward, the mouth is walled off and soiling by saliva is prevented. At the conclusion of the operation the rubber dam is turned down over the wound as a part of the dressing.

One type of graft is illustrated by the accompanying drawing. The incision is made so that it will be below, rather than over, the graft. The non-touch method is used. The ends of the fragments are exposed 1½ to 2 centimeters back and great care is taken not to perforate into the mouth cavity. The ends of the fragments are trimmed back until good, healthy, bleeding bone is reached. All cicatricial tissue should be excised. The rongeur forceps are used in preparing the graft and fragments. The ends of the fragments are squared off as well as possible, leaving a ledge above the graft which affords additional surface contact between the fragments and graft. When one end is well forward, an overlapping joint or a notching of the posterior fragment may be advantageous. The

iliac crest is exposed and a piece of the proper size removed with small chisels and thin saws. Usually there is considerable free hemorrhage which will require drainage of, and firm pressure to, the wound to control it. From this site, a shape suitable to the requirements of the case may be had with the minimum amount of modeling. Holes are drilled into the ends of the transplant and ends of the fragments, and short pieces of Belgian wire are threaded through and tightened. The subcutaneous tissues are closed with interrupted catgut and the skin closed with horsehair after all hemorrhage is controlled.

On account of the wound of the iliac crest the patients are kept in bed for ten days. The diet is at first liquid, then semisolid. Splints are left on for from three to four months, and removed only when the progress, as shown by the x-ray, is satisfactory.

In reviewing the cases the author concludes: (1) that restoration of function may be expected in a large percentage of cases; (2) that both surgeon and dental surgeon must give careful attention to the case to the final stage; (3) that the iliac crest is best suited for grafts of mandibular fractures; and (4) that good contact of grafts to fresh healthy bone and the maintenance of the graft in position by wiring is essential.

Results of Bone-Grafting Operations in the Treatment of Ununited Fractures of the Mandible. W. Maxwell Munby and A. D. E. Shefford. The Lancet, London, 1919, June 21, i, p 1070.

The results obtained by bone-grafting operations in the treatment of ununited fractures of the mandible, in the Northern General Hospital, Leeds, England, are reported by the authors on account of the great odontological importance of these observations. In their earlier cases, the free graft was invariably used, while in the later cases, a pedicled graft from the mandible (as introduced by Percival Cole) was adopted. Better results are obtained by the use of the pedicled grafts than by free grafts in that the former considerably shorten the period between the actual operation and the establishment of union. Where there are no teeth in the posterior fragment, the best results are also obtained by use of the pedicled graft. Certain cases where there is a large gap between the fragments are not suitable for a pedicle graft, especially when both ends of the fragments are pointed. In such instances a free graft is preferable. In free grafts the best results are obtained when the graft can be wedged into position and the periosteum stitched with fine catgut. The graft was obtained from the crest of the ilium in the majority of the cases.

Ununited fractures of the mandible, the result of gunshot injuries, are divisible into two classes, those having teeth in both fragments, and those having no teeth in the posterior fragment. In those cases where there is an absence of teeth in the posterior fragment, the operation is only indicated when the pseudoarthrosis is very lax, and marked improvement can be obtained, even if union of the graft is imperfect. Where there is already firm fibrous union causing little or no disability, the operation is not indicated. Bone-grafting operations give the best results when there are teeth in both fragments, which can then be completely controlled by a splint; eight of nine such cases were united at the end of

ten months. Absence of wound infection is an essential in order to secure satisfactory results. The amount of scar tissue present in the area of operation does not appear to influence the result, except that a slight sloughing of the skin flaps may occur when it is abundant. Bony union was obtained in ten of seventeen cases, equaling 59 per cent.

Radiographs in fractures at the angle region of the mandible are deceptive, inasmuch as they do not show the true extent of the size of the gap, which is frequently greater than it would appear, owing to the fact that the posterior fragment generally becomes displaced and lies at a deeper plane than the anterior fragment.

Teratoma of the Maxillary Antrum. H. E. Velarde. Philippine Journal of Science, 1919, xiv, No. 1, p. 161.

The case described was that of a 14-year old girl. The condition was of several years' standing, there being an increasing prominence of the right face. The right maxilla in the region of the antrum of Highmore was found to be prominent and bulging, extending to the side of the nose. There was no inflammation nor was there tenderness on pressure. A skiagram showed the presence of a tooth in the antrum. A radical operation was performed, the antrum being opened by a blow on a chisel, the membranous sac (containing fluid) was incised, and the sac and the single-rooted tooth buried in the roof of the antrum and the floor of the orbit were removed. An opening into the nose was left for drainage. The pathological examination indicated that the tumor mass was of the nature of an enamel organ or adamantinoma. The location is unusual.

Treatment of Ununited Fractures of the Jaws, Resume of Work Done by the Dental Department, U. S. A. General Hospital No. 11, Cape May, N. J. D. H. McCauley and D. L. Worthley. Dental Cosmos, 1919, lxi, p. 391.

War surgery has presented problems and difficulties quite different from those met with in civil practice and of these the dental surgeon has had his full share, particularly in the treatment of fractures of the jaws due to gunshot wounds.

In civil life, fractures of the maxilla and mandible are seldom complicated by a loss of substance. In war injuries, however, such a loss is the rule rather than the exception.

In the cases reported the patients had received their wounds from six weeks to four months previous to the time treatment was begun. Only a few were not in good condition, in spite of the fact that there was a lack of proper materials for treatment. Splints had to be devised from 2-franc pieces, chicken wire, telephone wire, and any other malleable metal which could be obtained.

Immobilization for from three to four months was always necessary to secure union when there was a loss of substance. Such immobilization should be instituted with the muscles relaxed and the jaws in the position of rest. The danger of trismus following immobilization is very slight.

To force the jaws apart gradually the authors suggest the use of a simple

tapered screw which can be adjusted by the patient himself. As the muscles seem to contract more at night during normal sleeping hours than at any other time, the patients were given a cork with a wire attached to place between the teeth before going to bed. Larger corks were substituted at regular intervals.

Food and fresh air are important factors in the successful treatment of any fracture. When the jaws have been immobilized, the food must, of course, be liquid or semi-liquid.

The authors report many interesting cases of fracture of the jaws which were treated successfully.

Mandibular Bone-Grafts. C. W. Waldron and E. F. Risdon. The British Journal of Dental Science, 1919, lxii, p. 201.

During the past three years, the surgeons doing this work have made a careful and uninterrupted study of all the various phases of the problems arising in cases of severe fractures of the lower jaw. With special reference to the transplantation of bone, the consensus of opinion appears to be that the transplanted bone has varying, but extremely important, osteogenetic properties. Bone-grafting of the lower jaw is an operative procedure whereby union of the fracture and restoration of function may be expected in a large percentage of cases. Complete co-operation and careful attention to every detail by the dental surgeon and the surgeon concerned, are essential from the early treatment to the final stage. Full advantage should be taken of the osteogenetic activity of the fragments, and of the transplanted bone, and also of the osteo-conductive properties of the latter. The iliac crest is, in the authors' experience, best suited in most cases for the bridging of defects in the lower jaw. The operation should be made as simple as possible, the object being to obtain good contact of the graft to fresh healthy bone of the fragments, maintaining the same firmly in position by wiring. The iliac crest graft is easily obtained, is very cancellous, strong, and particularly adaptable, as any surface may be used. The crest is easily exposed, and the required amount removed by thin chisels and narrow saws. Hemorrhage may be free, necessitating firm pressure and the insertion of a rubber-tube drainage. The graft is readily trimmed and fitted to place. Holes are then drilled in each end of the transplant, through which are threaded the wires previously inserted in the ends of the fragments. These are then tightened, fixing the graft firmly in position. The subcutaneous tissues are then united with interrupted mattress catgut sutures, and the skin is closed with horse-hair after bleeding has been controlled.

War Injuries of the Face. W. Rosenthal. Ergebnisse der Chirurgie und Orthopaedie, x, 1918.

Cooperation between surgeon and dentist is essential for the best possible results in these cases. Early treatment is of the greatest importance in facial and jaw injuries, a splint attachment being useful in the latter, so as to prevent displacement of the fragments while allowing the mouth a certain amount of gape. A correct technic is imperative, with attention to rigorous asepsis, com-

plete hemostasis, and systematic after-treatment. Defects of the lips should be repaired as a general rule with tissues from the upper lip in the case of lower lip lesions, and vice versa, supplemented by tissue from the cheek region. In the treatment of palatal defects, all closure by means of obturators and dental appliances is rejected by the author, in whose opinion all such defects of any size and in any position, admit of closure by plastic procedures. A pedicled flap including the whole thickness of the cheek is recommended for very extensive palatal defects, but with a more or less intact alveolar border. The flap is turned inwards to cover the opening, the wound in the cheek being brought together around the pedicle. At a later date, the pedicle is completely divided, in order to assist the desired transformation from external skin into oral mucosa and to favor efficient innervation from the palate. In bone-graft reconstruction of jaw fragments, a pedicled slide-graft can be obtained from the region of the mandibular angle or from the symphysis, or in the case of greater defect, from the opposite side. There is no limit to the size of free bone grafts for the jaw, which may be secured from the jaw itself, the ribs, the clavicle, the ilium, the tibia, and the metatarsus. In a general way, the ilium and the tibia would seem to be the most advantageous sources of the graft. The operative technic is of decisive importance, and the periosteum must be carefully preserved, guarding against its infiltration in case the work is done under local anesthesia. The graft is preferably transferred directly to its new bed, without preliminary immersion in solutions of any kind, and without any unnecessary handling. The periosteal edges are then united by catgut sutures, an important step in the operation, although the freshened end of the jaw fragment with its medullary tissue may also participate in the final union of the graft. Appropriate employment of free bone-grafts is often followed by perfect union and excellent functional results.

Ankylosis of the Jaw Due to Fixation of the Temporal Muscle. Gordon B. New. Journal American Medical Association, July 25, 1919, lxxiii, No. 4, p. 264.

It is sometimes difficult to determine definitely the side involved and the location of the fixation of an ankylosis of the jaw. This is particularly true in cases in which the jaws are fully formed before the ankylosis has occurred and in which there is no deformity. The diagnosis of the location is not so difficult when the fixation has occurred early in life, causing the deformity typical of such cases. Ankylosis of the jaw may be said to be of three types: (1) articular ankylosis, the most common type, due to the involvement of the temporomaxillary joint, (2) extra-articular ankylosis, in which the extra-articular structures or muscles are the cause, and (3) articular-extra-articular ankylosis, in which both the joint and the extra-articular structures are at fault. The clinical points of value in determining the side involved and the location of the ankylosis have been brought out in a recent article. The treatment of the articular type of ankylosis gives uniformly good results. It consists of an arthroplasty of the temporomaxillary joint through a curved incision 2 inches long, extending above the zygoma and down in front of the ear, and the removal of at least one-half inch of the

condyle and the ascending ramus of the jaw. It is not necessary to interpose any tissue in the new joint. When the jaw is not deformed, the operation is not difficult. If the typical deformity of ankylosis developed early in life is present, the joint will be very low and should be attacked from above by removing the lower margin of the zygoma. In this way the facial nerve is avoided, which is liable to injury if care is not taken in making the dissection in the soft tissues. The treatment of the extra-articular and the articular-extra-articular types of ankylosis are much more difficult and present many problems.

Relation of Dental Affections to Systemic Diseases. A. Stengel. The Dental Cosmos, 1919, lxi, No. 7, p. 619.

It is only recently that attention has been paid to the roots of the teeth as localities from which general infection can occur. These deep-seated, hidden, and incarcerated abscesses about the roots of the teeth are far more apt to become the source of generalized infection than are superficial conditions such as gingivitis or pyorrhea. Root abscesses become increasingly important in the involutional period of life, in the forties, fifties, and sixties. Whereas infections of the soft tissues are threatened in youth, infection of the alveolar process is to be anticipated in patients past forty years of age. Among the diseases due to oral or dental infection, the following are especially noteworthy: (1) Chronic anemia. (2) Chronic arthritis. (3) Chronic nephritis, Bright's disease. (4) Myocarditis; that is, weak heart. (5) Recurrent or relapsing endocarditis, or infection of the heart-valves. Beginning in adult life, an indefinite anemia, even approaching pernicious anemia in type and severity, is not infrequently referable to root infections. Elderly people in a chronic state of ill health are apt to be suffering from focal infection somewhere in the body. As a rule, these patients are anemic, and the cause of their secondary anemia should be sought for in the oral cavity, among other places. Oral infection is often, but by no means invariably responsible for the forms of chronic arthritis known as arthritis deformans. A case of vertebral arthritis, with pains radiating along the intercostal nerves, and chronic nephritis with albumen and casts in the urine, under the author's personal observation, was undoubtedly referable to infection disseminated from the mouth. Complete recovery followed within some months after the removal of all the patient's teeth, which were literally swimming in pus. The mouth is also an important but not invariable source of infection of the heart-muscle. Patients suffering from valvular disease of the heart must carefully guard against re-infection of the damaged valve, by exercising the greatest care about the mouth, the pharynx, the teeth, etc. The invasion of the streptococcus viridans, whose frequent habitat is in the mouth, is likely to reinfect an already damaged and less resistant heart.

Concerning root abscesses, it is necessary to make a distinction between an abscess that is infecting the system and one that is not, the latter can perhaps be drained and treated, with preservation of a valuable tooth. "There is no kind of thing that men are not attributing to root abscesses. A patient develops iritis, glaucoma, or panophthalmitis. These are all manifestations that may mean gout, arteriosclerosis, or syphilis; and yet some one is willing to say the con-

dition is due to a root shadow, and he takes the tooth out. Teeth should not be sacrificed in this haphazard way; and, worst of all, the obsession that oral infections explain everything should not lead us to overlook much more serious conditions." "The author, who has seen an instance in which a bad place in the x-ray plate was thought to be a bad abscess that did not exist, emphasizes that we must be more skeptical concerning the work of the x-ray artist; we should be less complacent, and not accept it lightly when there is a tooth to be sacrificed."

While a conservative radical method in the form of root amputations may be expected to cure many cases of root-abscess, the end result of the use of sera and vaccines in the treatment of root-abscesses will presumably prove wholly unsuccessful.

Pyorrhea and Autogenous Vaccines. G. M. Hoffman. Medical Sentinel, 1919, xxvii, No. 8, p. 991.

In reviewing 100 cases of pyorrhea alveolaris, each of which was examined from a direct smear of pus, plus cultures, the predominating organism of the infection was found to be streptococci pyogenese. The staphylococci, usually aureus and albus, was present in 30 per cent of all cases. Spirochetes, fusiform B. mould fungus and some diplococci are frequently found associated with the streptococci pyogenese. It has been the author's practice to treat these cases with autogenous vaccines of streptococci pyogenese, eliminating the extraneous organisms above cited. It may be of interest to note in but ten cases the amebæ buccalis was found, which organism for years was believed to be the causative of the majority of cases of pyorrhea.

Trench Mouth. H. L. Merkeley. Oral Health, 1919, ix, No. 7, p. 243.

This condition is well described by the designation as ulcerative interstitial gingivitis. A lack of oral hygiene is generally conceded as a contributing factor, and badly kept table utensils undoubtedly help in the distribution of the infection. Streptococci, and a very few staphylococci have been found, as well as anaerobes in the form of the bacillus fusiformis and its spirochaete, said to be a spore form of the bacillus fusiformis. Certain other ultra-microscopic forms are regarded by the author as chiefly responsible. The infection spreads with great rapidity and then assumes a stubborn chronic character. The clinical picture presents a slough closely approximating in general appearance that of an arsenic necrosis. The floor of the mouth, tongue and cheeks are rarely involved, although there is a considerable rise in temperature of the cheeks in acute exacerbations. There is also a general rise in temperature of a couple of degrees, due no doubt to the absorption of ptomaines and toxins. Pain may be severe enough to produce insomnia. The chief aim in the treatment being the removal of the cause and all contributing factors, the slough is best cleaned away by applying dry crystals of copper sulphate on a small pledget of cotton to each interproximal space where slough is present. The bactericidal application is allowed to remain three or four minutes, then washed out with a water syringe, this treatment to be repeated daily for three or four days, or if pain be intense, twice

daily. As a mouth-wash, undiluted Dakin's solution should be prescribed, with instructions to the patient to hold the solution in the mouth for some minutes, and use the cheeks to forcibly wash out the interproximal spaces. When the pain has disappeared and the slough has been cast off, which should be in four to five days, a thorough examination should be made for all irritants, and these should be removed even to the removal of all shell crowns and extraction of the third molars, if badly involved. It is noteworthy that the tissue flap covering a partially erupted third molar may form a pocket and thus become the seat of trouble. In fact, fifty per cent of cases treated to date point to this origin. Treatment by irrigation and wash should be continued until granulation-tissue has a good start, then iodine and violet ray massage may well be employed, keeping up the Dakin solution as a mouth wash intermittently. The destroyed gingival tissue will slowly regenerate, and give a fairly good effect even in extensive necrosis.

Radiography in Dental Diagnosis and Treatment. L. H. Woodroffe. British Dental Journal, 1919, xl, No. 13, p. 505.

The following classification of the indications for dental radiography is offered by the author on account of its simplicity and comprehensiveness:

1. Septic and inflammatory conditions, including (a) Pyorrhea alveolaris; (b) chronic rarefying osteitis; (c) alveolar abscess, acute or chronic; (d) fistula; (e) pericemental abscess; (f) empyema of antrum; (g) bone necrosis.

2. In orthodontia, including: (a) Late eruption of teeth, possibly due to absence of permanent teeth; (b) in cases of supernumerary teeth; (c) in cases of impaction; (d) determination of position of secondary teeth.

3. Root canal treatment, including: (a) Preliminary examination to determine the position and direction of roots, and subsequently (b) to see if filling has been correctly performed.

4. Root resection.

5. In all crown and bridge work: Not only should an examination be made before commencing work, to ascertain the condition of the teeth concerned, but an examination of any crowned teeth some months after the work has been done will lessen the large number of unhealthy teeth met with. A preliminary examination of the skiagrams of these teeth will also facilitate matters in respect to the treatment of root canals.

6. In making a general radiographic survey of the mouth, whether at the request of the careful dentist who wishes to be sure that no hidden trouble is present, or at the request of the physician who is faced with some nervous, alimentary or other disorder of obscure origin.

7. In oral surgery, including: (a) Extractions which, when unusually difficult, will be facilitated by a radiograph of the position and direction of the roots; (b) in cases where after extraction curettage may be necessary; (c) in cases of fracture; (d) in gunshot wounds; (e) in cases of cysts and tumors of the maxillae, whether malignant or benign.

As regards the examination of the mouth for septic or inflammatory conditions, intra-oral films are as a rule the most satisfactory, as the fine detail re-

quired for the recognition of these diseases is more easily obtained by placing the film in the mouth. This method should always be followed, though occasionally the exposure of a plate will give material assistance, as for example in suspected empyema of the antrum, where a special exposure giving a comparative view of the two antra should be made. In cases of fistula, stereoscopic exposures on extra-oral plates and on intra-oral films will frequently throw light on the course of the sinus and the cause thereof, the fistula being previously injected with a bismuth or similar opaque preparation. The presence of necrotic fragments of bone or broken and buried roots will also frequently be found to repay the increased trouble of stereoscopic exposures on plates or films. It is, however, in regulation work that the value of extra-oral exposures is most often seen, these being followed when found necessary by the exposure of intra-oral films as well. In regulation cases it will often be found that the information obtainable from a single exposure is misleading and a stereoscopic exposure will at once make the task of the dentist more simple.

From the viewpoint of orthodontia, radiography will at once settle the question as to the presence or absence of secondary teeth; if present, the stage of development reached and the approximate size of the unerupted teeth will be available, and from this the space necessary for their proper eruption can be judged. The direction in which the teeth are advancing and their approximate line of occlusion can be decided by means of a radiograph exposed at the right time, and occasionally by making attachments to unerupted teeth more can be done to regulate their advance than would otherwise be possible. The correct time for the extraction of deciduous teeth can also be determined. Finally, much may be done to avoid the overcrowding of teeth and faulty occlusion due to the malposition of third molars. Misplacements of these teeth are common, and cases of impaction and abnormality of roots will at once be brought to light by a skiagram of the area. In these cases it is very desirable to make stereoscopic exposures. Frequently an impacted and unerupted third molar will give rise to serious nervous disturbances, and such a tooth may only be discovered and its extraction enormously simplified by a radiographic picture of its relations.

The value of the x-ray in cases of fracture, of the formation of sequestra, and of loss of bone after shell and gunshot wounds is obvious, as it is also in cases of tumors of various types, and of salivary calculus. In these cases plates should in all cases be exposed, and inasmuch as in a large proportion of these conditions a clearer conception of the state of affairs can be obtained by a stereoscopic view, stereoscopic exposures should be made as a routine.

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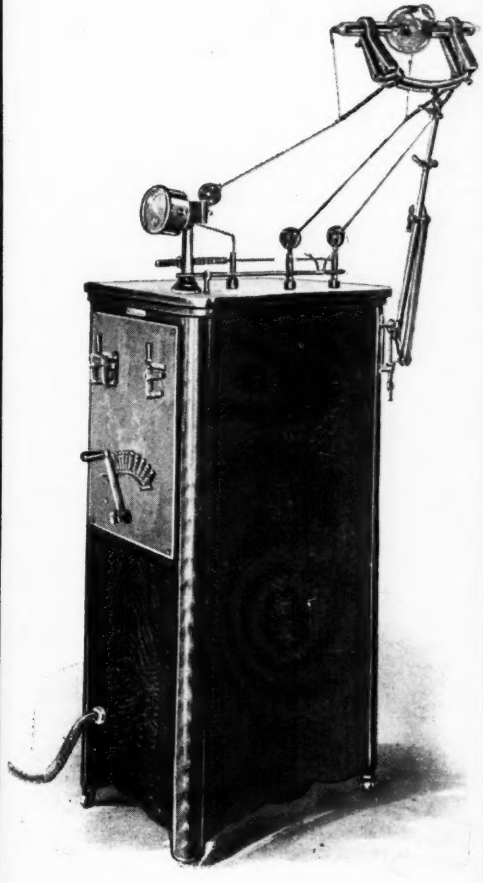

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